Penrose in the New Economy

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Abstract

Edith Penrose's theory eminently fit the mid-20th century firms and industries that she studied. What would she say about the very different firms in today's New Economy? To tackle this question, I update Penrose's original model with new theories of the firm that emerged after she wrote, including economics of contracting and of the new digital economy. I find that these new theories fit well with her concepts and help complete Penrose's model. I explore in particular how firms in the New Economy leverage their internal resources by using alliances, ecosystems, and platforms to access the services of external resources. These strategies expand what Penrose called the pool of resources available to the firm, even though they are governed by administrative mechanisms that she did not originally contemplate. We can now see that, while the firm is a bundle of resources, as she explained, not all bundles of resources are firms. In the New Economy, these other kinds of bundles are critical.

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When Edith Penrose wrote *The Theory of the Growth of the Firm* (TGF)[1], firms like Du Pont, General Motors, Standard Oil represented the pinnacle of the American economy. Her analysis was based on thoughtful observation of their practices, specifically those of the Hercules Powder Company. Her theory eminently fit these mid-20th century firms and industries.

Our economy today is ruled by new kinds of firms in new industries. The leaders in the new digital industries -- the New Economy for short -- are firms such as Intel, Microsoft, Google, Amazon, and Facebook. Smaller firms like eBay, Uber, and Airbnb offer equally important models that are different from the old firms.

What would Penrose say about this new industrial landscape? Does her analysis need revision for the 21st century firms and industries?

I will examine these questions from a distinct angle; I won't cover all of Penrose's thinking. I will focus on how firms leverage their internal resources by using alliances, ecosystems, and platforms to access the services of external resources. These strategies expand what Penrose called the pool of resources available to the firm, even though they are governed by administrative mechanisms that she did not originally contemplate.

In Penrose's last writings before her death in 1996, she expressed fascination at these new trends, but did not have a firm grasp yet on them or on how they fit her theories (Penrose chapter in Warner 1996). I was fortunate to have met her and corresponded with about my own work on alliances. I base my analysis on that interaction, as well as on a close reading of her last writings and of the reports of her biographers and reviewers (Penrose and Pitelis 2009; Kay 1999).

Section 1. How to Update the Penrose's Model

To "update" Penrose, we need to consider not only new evidence, but also new theory. A lot has changed in economic and management thinking from the 1950s to today. In particular, the theory of the firm has been revamped with a new focus on contractual economics both inside and outside the firm. These theories are particularly relevant to alliances, ecosystems, and platforms. Here again, Penrose's

[1] Referred to below as TGF, the book was published in 1959; the third edition, published in 1995, contains a new foreword by Penrose; the fourth edition, published in 2009, contains an excellent introduction by Christos Pitelis and reproduces Penrose's foreword to the third edition as an appendix. Citations here are from the 2009 edition (Penrose and Pitelis 2009), but refer to her 1959 text, her 1995 foreword, or to Pitelis's introduction, as noted.

last writings suggest that she too saw this relevance and was pondering how to work these new theories into hers.

Given that there is both empirical and theoretical "news" to mix into Penrose's model, I will separate the two and proceed in steps. Figure 1 shows the territory to be covered. Edith Penrose used the economics of the 1950s to tackle questions that arose in the firms and industries of the era (bottom left quadrant). We will extend her model in two directions. Section 2 asks how her original model applies to today's firms (bottom right). Section 3 asks what the new theories of the firm add to her model, even if applied just to Hercules and its ilk (top left). After that, Section 4 combines these two avenues to consider how an updated Penrose model would apply to our current era (top right). Section 5 concludes with a question that Penrose raised in her last writings: Is the firm itself undergoing a metamorphosis, turning into something totally new?

[Insert Figure 1 here]

Before embarking on an update of Penrose's original model, it is worth restating here its key features. As noted, we focus here on those aspects of the original model that will be relevant to how firms use external resources. We will highlight certain gaps in her model, not to point fingers, but in order to open up avenues for further thought.

1.1. The firm as an administrative organization and a pool of resources. The common reading of TGF today is that it defines the firm as "a collection of resources bound together in an administrative framework" (Foreword to the Third Edition, in Penrose and Pitelis 2009, p. 236). It is worth pointing out, however, that the link between these two key concepts -- the pool of resources and the administrative organization -- is not always clear in the book itself. These concepts first appear in the book as two separate sections (Penrose and Pitelis 2009, pp. 13-21 and 21-23). In Penrose's published case study of Hercules, she summarized the argument of the book: "A firm is *both* an administrative organization *and* a pool of resources" (Penrose 1960, p. 2. My emphasis).

"And" is a weak statement about a relationship between two concepts. What is missing is a notion that the administrative organization of a firm exists *to govern* the pool of resources. Without this link -- "to govern" – Penrose's two key concepts merely live in parallel. Implicitly, it she probably meant to say that administrative decisions drive the use of resources in a firm. But she does not ask in TGF how this link works. Had she asked this question, it would have likely drawn her into consideration of how ownership

works, how contracts work, and how other forms of authority influence the use of resources. We will return to this missing link in Penrose's original model in Section 3.

1.2. The administrative boundaries of the firm. In TGF, Penrose defines the boundary of the firm in terms of its administrative reach, not its ownership of resources: "The essential difference between economic activity inside the firm and economic activity in the 'market' is that the former is carried on within an administrative organization, while the latter is not" (Penrose and Pitelis 2009, p. 13). This sounds simple, but it isn't. The statement leads her into a discussion of what kind of administrative organization counts when defining the firm. For example, she concludes that mere financial ownership does not define the boundary, as investment trusts are not firms in her sense. From this she concludes that "it is the 'area of coordination' – the area of 'authoritative communication' – which must define the boundaries of the firm" (Penrose and Pitelis 2009, p. 17-18).

Even with this definition, the external relations of a firm appear to her as a grey area. She writes that "long-term contracts, leases, and patent license agreements may give an equally effective control, and yet cannot be easily treated in the same way (Penrose and Pitelis 2009, p. 18)." She does not say why they cannot be compared to intra-firm authority or treated in the same model. We will return to this blurry firm boundary in Section 2.

1.3. No inkling of the contractual theory of the firm. To our modern ears, Penrose's missing link about governance and her vague definition of firm boundaries cry out for application of what we now know as the contractual theory of the firm. Why did she not include these ideas in her study? After all, Ronald Coase had introduced the idea over twenty years before (Coase 1937). Does it somehow not fit? I don't think that is the case.

The answer to why Penrose didn't cite Coase seems to be: Nobody (who mattered in Economics) knew of Coase! Fritz Machlup, Penrose's thesis supervisor, wrote two texts on industrial organization in the mid-1950s, neither of which mentioned Coase. A decade later, Machlup delivered his presidential address to the American Economic Association on the very topic of theories of the firm. In it, he exhaustively listed ten concepts of the firm, none of which included contracting or transactions costs -- and Coase was nowhere in his long bibliography (Machlup 1967).

In his Nobel lecture Coase himself later wondered why it had taken so long for his now-classic article to enter the mainstream (Coase 1992). He attributed its rediscovery in part to the later work of Oliver

Williamson and others. Whatever the reason for the delay, the contractual approach is now entrenched in our conception of the firm. Furthermore, even if it was not on the horizon for Edith Penrose in the 1950s, she did recognize its importance in her last writings, as discussed later.

1.4. Measuring the size of the firm. Given the above, it comes as no surprise that it is hard to measure the size of the firm by Penrose's definitions. How much administrative authority defines the boundary of the firm? What resources do we include or exclude from the pool that defines the firm? Penrose appears not to have been too bothered by these measurement questions, perhaps because she was not conducting an empirical analysis of multiple firms. Most of her evidence came from the Hercules Powder Company, a firm that was by all accounts well-defined – it owned most of its businesses outright and its activities were all closely related in terms of production and customers. Having myself interviewed managers at Hercules for my doctoral thesis thirty years after Edith Penrose did so, I can well imagine that they would have had little patience for questions about what is or is not inside their firm.

Penrose thus quickly settled on a proxy to measure the size of a firm, since the subject is obviously relevant. Ideally, she said, size should be measured as "the present value of the total of its resources (including its personnel) used for its own productive purposes" (Penrose and Pitelis 2009, p. 22). She surely meant not the NPV of the resources as assets, but the NPV of the stream of services they provide, a concept she had just explained in a preceding paragraph. Today, we might equate this with the market capitalization of a public firm, which in theory equals the NPV of the firm's future cash flows. For some reason, she did not select this proxy, but instead chose fixed assets as a reasonable measure of firm size. With all the emphasis on managerial resources in TGF, this seems like a narrow measure. Fortunately, this measure did not restrict Penrose from thinking of firm growth in other terms – particularly, the growth of the pool of resources and of the administrative reach of the organization. We will return to these measures in Section 2.

Edith Penrose's original model of the growth of the firm was a masterpiece – it reframed classic topics in economics in ways that invited in concepts from the then-emerging literature in management. Her work was based on real-world observation, not on ideal types. At the same time, it can bear extension and revision. Times have changed and the best thinking in the field has changed. What follows builds on Penrose's achievement and attempts to strengthen her framing and intent.

Section 2. How New Economy Firms Stretch the Penrose Model

To see if Penrose's ideas apply today, let's start with the data, as she did. Hercules is no longer a bellwether of the American economy, as it was in 1960. At that time, it was a medium-sized (165th on the Fortune list) chemical producer that was hitting its stride and seems to have been attractive to investors. It produced a closely related set of products, sold to other businesses. (Penrose 1960.)

2.1. What do New Economy firms look like? Today's iconic firms are a world apart from Hercules in 1960. Table 1 shows selected financial statistics for Hercules in 1960, and for Ashland Global (Hercules's successor) and seven New Economy firms in 2018-2019. From left to right, the table shows market capitalization, sales or revenues, total assets, and number of employees. We should take these numbers as rough indicators, since some of them move around a lot, and financial years and definitions vary. We will focus on the ratios calculated from these basic measures, shown in columns 5 through 9. The new economy firms are sorted by growth rate.

[Insert Table 1 here]

Let's examine this table in reverse -- from right to left, starting with the yearly growth rate of revenues (column 9). By Penrose's telling, Hercules in 1960 had not grown so fast as some other firms in its field, but faster than its industry as a whole. She estimated the growth of fixed assets at around 5%, the number shown in the table. Fast forward to today, and we see Hercules's successor firm shrinking not growing (by revenue).

And the New Economy firms are booming, especially the newest ones. Facebook's growth was explosive, while Amazon, Google, and Apple grew at double digits; Microsoft, Intel, and eBay by now seem to be more mature, like perhaps Hercules was in its day. How did the new firms grow so fast? Penrose predicted that there was a limit to the rate of growth of firms, not to their size. Have there been no such limits for Facebook, Amazon, Google, and Apple? The rest of the tables provides some clues.

The fast-growing new firms have high valuations in the market (col 6), but Hercules in its heyday was not out of line with them in this sense. What is different for the new firms is their high sales per employee (col 7) and their high capital-labor ratio (col 5). On these two counts, Facebook, Google, and Apple operate with much fewer personnel than Hercules did in 1960 and than Ashland does today. (Amazon is more similar to Hercules in this sense, but in this sense only.)

2.2. How network externalities drive growth. Did firms like Amazon, Google, and Apple break through or skirt the "Penrose effect," whereby the growth of a firm is limited by the rate of growth of resources? (Uzawa 1969; see a more recent treatment in Vidal and Mitchell 2018.)? Not necessarily.

First, because of their high capital intensity, financing would be their most pressing need in order to grow, less so management personnel. Capital was available because of their high valuation, which, in a circular manner, was so because of the firms' high growth rates. Management would seem to have been available and able to be "stretched" rapidly, for reasons we will examine in a moment.

The second reason why the firms grew fast despite a possible Penrose effect is because their production function differed from that of traditional industrial firms like Hercules. New economy firms benefit from economies of scale not only in production, but also in demand. What we now know as network externalities make their product more valuable to the buyer, the more of it is sold (Shapiro and Varian 1999; Goldfarb and Tucker 2019). This feature led to the "get big fast" strategies of New Economy firms, and also to their acquisitions to gain or protect market share. These network externalities were not unique to the New Economy or to the 1990s and 2000s; they were important in earlier standards battles in video-recording, CDs, and other technologies. At the same time, the New Economy firms we are examining here relied more on these effects than previous leading firms, and certainly more than the leading chemical and industrial firms in Penrose's day.

In essence, these network effects meant that consumer value was created by growth itself, leading to still higher sales, higher valuations, and easier access to capital, which in turn enables further growth. These demand-side economies of scale mean that growth was "pulled" by external factors. Penrose did explain how growth can be limited or encouraged by external market opportunities, but could not foresee the increasing returns to scale in demand that only became common in the last decades. I call this a different "production function" from the traditional one because the relationships between inputs and outputs is different than what Penrose observed.

Network externalities in effect create an additional factor of production – individuals themselves, as consumers and producers. The so-called Web 2.0 businesses that arose after the internet was established notoriously use data and inputs from consumers to sell products and services to others, and to the same consumers. Facebook is a prime example, as are Airbnb, eBay, and Uber. In each case, the number of consumers or producers increases the value of the product to each consumer.

2.3. How alliances *expand* managerial resources. There is another way in which the production function changed in the last few decades, and it is consistent with Penrose's predictions. She explained how firms would have to go outside of their boundaries to acquire new resources if they wanted to grow faster than their internal resources allowed. She considered managerial talent, personnel, and entrepreneurial skills to be the chief limitations that might slow down a firm intent on fast growth Firms in her view would acquire and merge to gain the needed resources.

The evidence suggests that the New Economy firms, too, acquired smaller firms as a way to expanded managerial and entrepreneurial resources. Often, these acquisitions came with kernels of new products that were then developed in the larger firm. Cisco, Google, Apple, and Microsoft followed such strategies.

The New Economy firms also accessed external resources through deals short of merger or acquisition. Alliances are just that -- organizational mechanisms to govern an incomplete contract between firms, a relationship that is deeper than an arm's length trade and short of a merger (Gomes-Casseres, 1996).

The rate of alliance formation shot up during successive ways of innovation, as shown in Figure 2. The chart shows the number of new alliances formed every year worldwide, according to Thomson Reuters data. This source reports two types of deals – alliances that are purely contractual, and those that include a component of equity investment, either in a stand-alone entity (classic joint ventures) or as a minority investment of one firm in another. These data are admittedly incomplete and the alliance definitions are perhaps legalistic, but they do cover a wide swath of industries better than any other source (Schilling 2009). The chart shows several waves of alliance formation, punctuated by periods of declining alliance formation. The first wave (1990-1995) corresponded with the rise of computer hardware and software – the heyday of Intel and Microsoft. The second wave (1996- 2001) corresponded with the rise of the internet and dot.com businesses, such as Amazon and Google. The third wave (2002-2007) corresponded to the rise of Web 2.0 businesses. After the great recession (2008-2010), the use of alliances moderated, but a recent up-tick seems to correspond to deals in emerging technology industries (Saada and Gomes-Casseres 2018). Over these decades, the alliances in information technology, biopharma, and media industries were mostly contractual, with equity joint ventures being more common in traditional industrial sectors like automobiles, retail, and energy.

[Insert Figure 2 here]

In some industries, like biopharma, alliances are today as important as internal spending in developing new products. These alliances allow faster expansion of a business in part because they bring the services of external resources that would be time consuming or impossible for the firm to develop, just as Penrose predicted for growth by acquisitions.

These alliances also release another constraint on growth that Penrose did not foresee. Her model of technical progress was colored by the chemical industry, where each product is valued by buyers for its inherent material features. Many of the new economy industries, however, are based on systems of products (Shapiro and Varian 1999), in which the value of one product depends on the buyer also using a complementary product – say, hardware and software. This means that the growth of one firm may be limited or encouraged by the growth of firms making a complementary product. Microsoft and Intel are prime examples -- each has needed the other to grow, and so their alliance has helped coordinate their actions (Yoffie, Casadesus-Masanell, and Mattu 2004).

These complementarities give rise to ecosystems, which I define as simply a set of companies linked together by alliances (Gomes-Casseres 2015; for a narrower definition, still consistent with the argument here, see Jacobides, Cennamo, and Gawer 2018). In her later work, Penrose shows interest in these networks and relates them to work on geographic "clusters." The notion of ecosystem that I use here is not necessarily bound by location, so not a cluster in that sense. The ecosystem of allied firms in systems businesses are usually global, and link firms that are adjacent to each other in the industrial or functional sense.

Penrose did not foresee these complementarities in the markets she studied, and so did not struggle with the question of how to govern resources that are needed to exploit them. She did observe that Hercules had a joint venture (Penrose 1960, p. 16), but did not explore why the firm chose that way to govern the relationship, as opposed to an acquisition. We will return to this point later, as new economic theories help us understand the choice.

2.4. How digital code and platforms *stretch* managerial resources. There is one last way in which the New Economy firms were able to defeat the Penrose effect. The very technologies they developed – digitization, communication, and data analysis – also enabled them to "stretch" their managerial and entrepreneurial resources as their businesses grew. As a result of this greater leveraging of their existing resources, the reach of their administrative authority could grow without the resources themselves expanding. How did they achieve this magic?

The magic comes from *code* – the commands embedded in hardware and software that tell a system how to behave. In a landmark book, Larry Lessig explained how in the digital age, code shapes behavior just as much as laws, norms, and markets do (Lessig 2001). The code embedded in our digital systems is the architecture that guides our interactions. Think about Facebook – how their member pages are coded determines who sees what, who can post what, and how members can communicate with each other. In eBay, code shapes how price setting occurs. In every smartphone, code shapes how we relate to each other, buy things, get our news, and more.

Because code shapes behavior, it can be used for administrative coordination, and to exercise authority at a distance, so to speak. Managers in a firm can use code to implement organizational routines and policies, and today even to make decisions. This sounds like the ideal that Penrose described: "[O]nce an administrative framework has been created . . . and once policies are laid down . . . no further intervention by the central management is required," so long as the decisions to be made conform to the established policies (Penrose and Pitelis 2009, p. 14). In this way, code can extend the reach of a "central management" just as policies and administrative rules would. Of course, to deal with change, one still needs personnel to make new decisions, at least until the code advances to true managerial intelligence.

Having stated starkly this argument for how code stretches resources, we can now see how it applies more broadly to any "platform" business. The narrow definition of a platform business is one in which different market participants interact with each other in a digital space, where code sets the rules of communication, search, matching, and even the terms of agreements between parties. eBay is a classic digital platform. It is not surprising then that eBay achieved a market value seven times that of Hercules, with only 30% more employees, and even though it's price-to-book ratio was lower than that of Hercules at the time In other words, it appears that the code in the platform extends the reach of administrative coordination practically for free.

A broader definition of platform business is one in which technology sets the terms for interaction among complementary firms. In this sense, the iPhone and Android platforms shape who can make what complementary product and how the product should work. More broadly, Intel and Microsoft's platforms shape the interactions among their partners. One of the reasons behind Apple, Intel, and Microsoft's growth and success is that they defined their strategies in terms of platforms, rather than discrete products (Yoffie and Cusumano 2015).

This idea too is one that Penrose would not have encountered in her research in chemicals – though she does see firms as developing distinct technological and market "bases" (Penrose and Pitelis 2009, pp. 97-105). These bases shape how the firm's resources are used, which markets are addressed, and which acquisitions may be justified. But Penrose does not see them as mechanisms for extending the reach of the firm's scarce managerial talent.

With all these new phenomena to explain, does Penrose's theory of the firm still apply? In short, her description of what firms *are* no longer rings as true. But the mechanisms of administrative governance of a pool of resources are still there, even if they may work differently than she described. Penrose's conclusions may need revision, but her way of thinking is still illuminating. It remains so, and even gets stronger analytically, when we introduce new ideas in economics.

Section 3. Updating Penrose With New Theories of the Firm

We will consider now how Penrose's original model can be extended with ideas from Coase and from the broader school of thought on the economics of contracts, which includes three other Nobel Prize winners – Oliver Williamson, Bengt Holmstrom, and Oliver Hart. Although Edith Penrose didn't know about Ronald Coase when she published TGF in 1959, she did know and appreciate Coase's ideas when she wrote her preface to the third edition in 1995. That preface was one of her last published writings and it shows her keen interest in many new schools of thought.

3.1. Edith, meet Ronald. Penrose's other last piece of writing is a more complete statement about theory than the preface, but it is hard to locate – you have to go to the library for it. Her chapter on "Growth of the firm and networking" in the multi-volume *International Encyclopedia of Business and Management* (Penrose in Warner 1996) is a rewarding read. In it, she states clearly how she thinks her work fits with transaction-cost economics:

> Broadly speaking, there are two major types of explanations for the growth of firms in a market economy... the two approaches ask different kinds of questions, thus emphasizing different considerations regarding the behaviour and nature of the firm. One explanation rests on an analysis of the role of market transaction costs... The other explanation starts with an analysis of the nature of the resources available to the firm... *The two approaches are not mutually exclusive*. (Penrose in Warner 1996, p. 2441. Emphasis is mine.)

Saying that two approaches are "not mutually exclusive" is a weak statement of how they fit. At least they don't conflict, she is saying. Penrose's statement appears to imply that the two schools of thought can play in parallel, each doing its own thing in the theory of the growth of the firm.

3.2. Ronald, meet Edith. I think that the link between the two approaches is much stronger than just parallel-play. In fact, Coase himself found the two more than just compatible. He wrote to Christos Pitelis, the foremost biographer of Penrose's scholarship: "I do not regard her views as an alternative to mine in 'The Nature of the Firm'… but as *a necessary addition* to it… [T]here has been insufficient attention to the role of the firm in 'running a business.'" (Pitelis Introduction in Penrose and Pitelis 2009, p. xxxii. My emphasis.)

"Necessary addition" is a strong statement. A close reading of Coase's classic article shows exactly where Penrose's concepts would fit in his model:

> [T]he operation of a market costs something and by forming an organization and allowing some authority (an 'entrepreneur') to direct the resources, certain marketing costs are saved. The entrepreneur has to carry out his function at less cost, taking into account the fact that he may get factors of production at a lower price than the market transactions which he supersedes. (Coase 1937, p. 392.)

In other words – Penrose's managerial authority is needed to run the organization that Coase's argues may beat the market costs of a transaction. That is what Coase meant by "running the business." Of course, Coase himself did not explore that aspect of the firm, because he was focused on the transactions generated by the firm's activities. But, with hindsight perhaps, he might see Penrose's world as fitting snuggly next to his. In a way, it helps complete his model.

The reverse is true too – Penrose's model, in turn, depends on Coase's ideas, even if she perhaps did not have time to fully realize this. In her last piece, she wrote that transaction costs are important in two types of decisions: (1) whether two companies should merge, and (2) how firms are organized internally (Penrose in Warner 1996). Let's examine each type of decision in turn.

3.3. Penrose and Coase at the boundaries of the firm. The first way in which we can extend the Penrose model is in the analysis of the boundary of the firm. Consider the situation of firms that grow through acquisition, which is growth through extending their boundary. Penrose recognized that firms faced with new opportunities may build the capabilities needed, or buy products on the market, or "embark on

expanding its ownership connections with another firm." The choice, she explained, depends on "relative costs, and in particular the transaction costs of the different forms of action" (Penrose in Warner 1996, p. 2442).

The most important applications of transaction costs, in her telling, is in vertical integration decisions. In fact, on that matter, Penrose used transaction cost reasoning in 1960 without calling it that (Kay, 1999). To explain why Hercules chose not integrate forward, she wrote: "[T]he technical relationship with customers so carefully cultivated… would be impaired if customers had any reason to fear that Hercules would itself become a competitor" (Penrose 1960, p. 20). In the spirit of Coase and Williamson, one might say that the buyer's fear of being held up by an opportunistic integrated-Hercules would have raised for them the cost of transacting with Hercules, and the reduction in sales would deny Hercules some marginal profit. So, Hercules would not take this step, and instead would maintain its market or contractual relationships without ownership expansion. In other words – the firm would not grow beyond this boundary. Penrose and Coase would be saying the same thing on this case, just using different analytical tools.

Coase and Penrose also agreed on another thing – a blind spot, it turns out. Neither at first realized that the boundary choice facing a firm was not just to merge or to trade, but that it also included to ally. Williamson too at first did not allow for organizational structures between market and hierarchy, but he soon did (Williamson 1979). By the time of Penrose's last writings, she too recognized the rise of alliances, and appeared fascinated by the trend. She found insight in Richardson's classic piece on the organization of industry (Richardson 1972), and was intrigued, it appears, by my own work on collective competition (Gomes-Casseres 1996).

Knowing of her later interest in alliances, one wonders why she did not take notice of them when she studied Hercules in the 1950s. Perhaps there weren't many of them, though Hercules did have marketing and technology agreements with Du Pont, as was common in the industry (Stocking and Watkins 1946, p. 464). Penrose does report on a Hercules joint venture with coke-producer Alabama By-Products Corporation (Penrose 1960, p. 16), but she does not explore how it worked. It seems clear today that this venture was created to link the firms without merging them, because each was rooted in a much larger business in a different industry (Kay 1999). By the time I studied Hercules for my thesis in 1984, the company had expanded abroad using many joint ventures and it was launching a global alliance with an Italian firm (Gomes-Casseres 1985, pp. 580-587). The Hercules alliances can now be explained by a transaction-cost theory of joint ventures (Hennart 1988; Gomes-Casseres 1989) and by

recognizing that alliances are mechanisms to govern incomplete contracts (Gomes-Casseres 1996). These mechanisms empirically blur the boundary of the firm, but conceptually they fit in an extended Penrose model.

3.4. Penrose and Coase on the governance of resources. The second way in which the new theories of the firm can extend the Penrose model is even more fundamental than the question of the boundary of the firm. Penrose wrote in her last piece: "Transaction costs have a major effect on the *internal administrative organization* of firms" (Penrose in Warner 1996, p. 2442. Emphasis is mine). That phrase – internal administrative organization – is what much of TGF is about. She now finds that her model can be extended with Williamson's analysis of the M-form in terms of transaction costs (Williamson 1975).

We can dig deeper in this vein. If transaction costs help shape the administrative workings of a firm, then they lie at the core of Penrose's picture of the firm as a pool of resources governed by an administrative authority. How is that? The key lies in the word "governed," which, as we saw, was not always clear in Penrose's original model. If we now extend her model, we can see how administrative structures "govern" the pool of resources, and also see the role of contracting costs in this process.

To see how resources are governed, consider Penrose's original argument that it is not resources themselves that matter, but the services they produce (Penrose and Pitelis 2009; this point is emphasised in Penrose 1955). A resource is an asset; providing a service is an activity. The activities of a resource are what yields value, and they inherently involve a relationship between parties, a buyer and a seller, so to speak. Think of a simple value chain at Hercules: The R&D resource of the firm provides a service to the Manufacturing resource by designing the product to be made. This resource in turns provides a service to the Marketing resource by making the product and preparing it for sale. The latter resource provides services to the buyer by informing them, negotiating a price, and selling the product.

More broadly, we can think of the resource bundle inside a firm as consisting of discreet resources that are complementary. The services of each thus need to be coordinated with those of the others for the bundle to be most productive (Gomes-Casseres 2015). Because of this need for coordination, the resources are "linked" (Kay 1999) and benefit from being governed together.

How do organizations govern these relational activities? Economics of contracts and transactions costs are key factors in governing a pool of resources (Teece 1980). Hercules grew organically and diversified into related fields because its activities were integrated at a technical level. The firm's resources in one field provided services that could be redeployed or expanded into an adjacent field. That led the firm to

develop firm-specific assets in explosives, naval stores, and nitrocellulose. Later, Penrose would explain that "firms own – that is, have property right in -- or contract respecting such assets and thus gain economic rents from their use" (Penrose in Warner 1996, p. 2442). In other words, she too ultimately found transaction-cost analysis useful in explaining how firms organize the services that flow from their resources, that is, how they govern their resources.

The picture that emerges from these extension of the Penrose model is shown in Figure 3, which builds on a useful sketch in Kay (1999). Each of the two firms in the Figure 3 owns three resources, labeled R. Inside each firm, these resources are complementary or are linked by transactions (labeled T), which are governed administratively. The firm is thus not a disconnected set resources, but a bundle that is governed by the administrative structure of the firm, as Penrose defined it. The boundaries of the firms in this graphic are shown by the dotted line. After all, even Coase said: "It is not possible to draw a hard and fast line which determines whether there is a firm or not. There may be more or less direction" (Coase 1937, p. 392, fn. 1).

[Insert Figure 3 here]

The chart also shows two transactions between the firms that are governed by alliances, labeled A. The alliances are shown as connecting specific resources within the firms, as that is often what they do. Pure market transactions are not shown. Of course, one firm could also acquire the other, in which case their resource bundles would be combined in one larger dotted-line circle and the new links between the merged resources would then need to be governed. That last step is what Penrose referred to as the integration of resources after a merger, much as the term is used today.

This modest sketch shows how new theories of the firm can not only coexist with Penrose's view of the firm, but how they can be an integral part of it. Transactions take place between resources both within and outside the firm, and they are governed by administrative structures of various forms, from whole ownership inside the firm to contractual alliances and joint ventures. A given bundle of resources, therefore, can be inside a firm, or can span across firms. In other work, I have shown how this integrated model of resource combination helps in the analysis of strategy, entrepreneurship, and international business (Gomes-Casseres 2015; Gomes-Casseres, Jenkins, and Zamborsky 2019; Gomes-Casseres 2019).

Section 4. Applying the Updated Penrose Model to the New Economy

To complete our update of Penrose, let's return to some more data on the New Economy. We are now armed with new thinking in economics too. Instead of studying Hercules in the mid-20th century, let's

imagine that Penrose would be studying Apple Computer and its ilk in the late 20th and early 21st centuries.

The story of Apple has two phases: (1) the rise and fall of the Apple personal computer (1970s through the 1990s); and (2) the rise of the iPhone and related products (2007 onward). In each phase of the story, there are other players and rivals that we must also take account of – IBM, Intel, and Microsoft in the first phase, and Google in the second phase. There are good cases and books about these companies, so we will not repeat the detailed facts here (Yoffie and Baldwin 2015; Yoffie, Casadesus-Masanell, and Mattu 2004; Yoffie and Cusumano 2015). Stylized facts are enough to show how the extended Penrose model applies.

4.1. The rise of new firms in personal computing. The birth of Apple was classic Penrose. She described in TGF how small firms could enter a new business that lay in the "interstices" between large incumbent firms, that is, a narrow space ignored by the larger players (Penrose and Pitelis 2009, p. 196). Apple's first personal computers were clearly in a narrow space ignored by IBM and other incumbents, and occupied at the time by hobbyists and educational machines like the Commodore. The Apple II, introduced in 1977, was the first personal computer used by business professionals, who were running the spreadsheet killer-app VisiCalc.

By the time Apple entered the market for professional use, IBM did take note, as Penrose would have predicted. But she also argued in TGF that, at this stage, the small firms would be mopped up by large firms, through acquisition or competition that favored scale. That did not happen in the Apple story -- IBM did not end up winning this game. Instead, Intel and Microsoft did. These two entrants also started in interstices, but they grew to dominate even the larger incumbents like IBM. Why this happened is a story outside of the classic frame of TGF.

Intel did have some valuable resources at the start, but its rivals were much larger. In fact, it lost the market for DRAMS to larger Japanese competitors, as Penrose might have predicted. But this did not happen in its line of X86 microprocessors, where Intel became dominant, to this day. Microsoft too, started with smarts, but not much else – in fact, it acquired the DOS operating system from an even smaller third party. Again, Microsoft grew to dominate personal computing software with its DOS, Windows, and Office suite of products, to this day. IBM, as we know, fell by the wayside in this story, and ended up selling its personal computer business to Lenovo. These are not outcomes that Penrose would have predicted, based only on her reasoning in TGF.

4.2. The economic power of ecosystems. We need an extended set of concepts to understand the fall of Apple, and the concomitant rise of Intel and Microsoft. Some missing pieces of the puzzle were already mentioned – alliances, ecosystems, and platforms. These pieces fit well in the extended Penrose model developed above. Now we will see why they are essential to understanding the growth of New Economy firms.

As is well known, IBM did respond to Apple's entry into business computing by introducing the IBM PC in 1981. But the large incumbent did not have the vision and concrete capabilities to compete in this new market. Also, in a classic case of how incumbents miss out on disruptive technologies, the personal computer was outside of IBM's mainstream and threatened its existing business (Christensen, Raynor, and McDonald 2016). So, it reached outside the firm to Intel for a microprocessor and to Microsoft for an operating system. These relationships were classic alliances. IBM invested in Intel and struck a tough supply agreement, which forced Intel to license its technology to numerous second sources. IBM also had a supply agreement with Microsoft, but famously wrote a non-exclusive contract. Intel and Microsoft at first did not have much to do with each other, but over time developed the usual alliance mechanisms to coordinate their decisions (Yoffie, Casadesus-Masanell, and Mattu 2004; Carroll 1993). IBM's reach outside of its boundaries is akin to what was discussed in Section 3 and illustrated in Figure 3. Together, this bundle of resources did have the strength to take on Apple. But this was not a bundle governed by administrative authority within the ownership boundaries of a single firm. The administrative mechanisms and contracts between the firms were critical to coordinating the services that flowed from the resources of different firms.

One part of the puzzle remains: How did this alliance grouping end up defeating Apple? The answer again is outside of the scope of Penrose's original model, but fits in the extended model developed above. It was network externalities, discussed in Section 2, that drove the growth of the IBM PC market, and destroyed demand for the Apple product. These network effects stemmed from the ecosystem around the IBM PC, which in turn depended on the technical platform the partners created. Three things were key. First, IBM PC clones rose rapidly after Compaq reverse engineered the IBM design. Second, Microsoft had the right under its non-exclusive contract to sell its operating system to these clones. Third, Microsoft actively promoted the rise of third-party applications on its system. These three things, plus the early push of IBM marketing, caused a virtuous cycle in which the IBM PC became more valuable to users the more units were sold – a classic network effect. Intel also benefitted from the more traditional economies of scale in production and in R&D.

Apple would have none of this. It did not allow clones of its machine, even after appearing to strike a deal with Motorola to license its system. It did not allow others to use its operating system, which in turn favored its own applications. As the virtuous cycle drove sales of the IBM PC system, a vicious cycle set in that depressed Apple's sales. The same network externalities were at work here, they just pointed down rather than up. In no time, Apple's personal computer market share fell to single digits. All this while Apple's MacIntosh was probably based on better technology and technical resources.

In our extended Penrose model, ecosystems of firms are just different ways of bundling resources than firms – in fact, they were essential to the success of their member firms.

4.3. Ecosystem competition. Apple did learn its lesson. When it introduced the iPhone, it too used alliances, ecosystems, and platforms to acquire access to resources and stretch its administrative reach, as discussed in Section 2. It launched the iPhone with an exclusive alliance with AT&T, and over time developed multiple alliances to provide content, apps, and components. These relationships and the platform itself had first arisen with its iPod line of products. That music player, too, only succeeded because it enabled users to access a large pool of content, secured by Apple through contracts with media companies. Similarly, it acquired from a third party the technology for Siri and even the term *iPod*. In this way, Apple "remixed" resources from far and wide – its own and those of its partners (Gomes-Casseres 2015).

Google took this strategy one step further with its Android platform. Unlike Apple, Google also licensed hardware makers to produce handsets for the platform and opened the operating system to input from others. This ecosystem, therefore, is more open than that of Apple's iPhone. That accounts for greater competition within the Android system, which has led to lower prices and a larger global market share as compared to Apple's iPhone. Here too, the success of Google depended on an extensive array of alliances and a robust ecosystem, not just on the internal resources of the leading firm.

The role of the ecosystem in Apple's and Google's successes is even more striking when we compare it to the predicament that befell General Magic in the mid-1990s. This spin-off from Apple had practically invented the smartphone in terms of its functions, basic design, and attractions to users. It was backed by financing from large companies (Apple, Sony, Panasonic, Philips, and others) and assembled a dream team of programmers and engineers. But its product failed miserably, because of the lack of an ecosystem to support it. There were no fast processors, touch-screen technology was poor, the internet was not what it is today, and there was no attractive content, as music had not yet been digitized fully.

But its technical personnel (resources, too, according to Penrose) were superb, and they went on to lead development of the iPhone, Android, eBay, Nest, and more (see the documentary on *General Magic,* Kerruish and Maude 2019).

Section 5. Metamorphosis of the Firm?

This analysis of New Economy firms would seem to have taken us far from the original Penrose model in TGF. But perhaps not. In her discussion of the boundary of the firm, she writes:

> It is essential to distinguish between the extent of economic power and the size of the industrial firm proper. For an analysis of economic power there is no doubt that the industrial firm is *not* the most relevant unit; . . . [but] an attempt to define the firm according to power groupings would produce too amorphous a concept to handle. (Penrose and Pitelis 2009, p. 19. Emphasis in the original.)

We now live in a world where "economic power groupings" indeed are important. At the time, Penrose may have been referring to cartels, which were common and varied in form in the interwar years. Some of these groupings looked more like today's networks of interfirm relationships, and less like classic cartels (Stocking and Watkins, 1946).

Today, this idea also applies to the ecosystems and alliance groupings that drive New Economy growth. These power groupings shape how resources are used, constrain and encourage growth, and may determine winners and losers in business rivalry.

Note, however, that Penrose originally felt that trying to define and analyze these groupings would result in "too amorphous a concept to handle." That is no longer the case. With modern theories of the firm, new economics of contracting, and a deeper understanding of inter-firm transactions, we can tackle these groupings too.

5.1. Firms and resource bundles. Pitelis reports that Penrose "struggled with the idea whether such networks, clusters, webs, etc., require a theory of the firm that was different from hers" (Pitelis in Penrose and Pitelis 2009, p. xxvii). The answer, as we have seen, is partly yes and partly no. The strict theory she developed falls short. But one can build on her theory to explain the new phenomena.

There is a simple way to say how her theory continues to apply, and how it is modified. Penrose in TGF explains that the firm is a bundle of resources governed by administrative authority. That is still true today. But we also see today that not every bundle of resources governed by administrative authority is

a firm. In fact, the firm, or firm boundaries *per se*, are better seen as variables in a general model of resource governance. What matters for profitability and success in competition is that the right bundle is assembled and then that it is governed appropriately – whether this is done through a firm or an alliance or an ecosystem has become a secondary matter (Hennart 1994; Gomes-Casseres 2015; 2019). In short: A firm is a bundle of resources, but a bundle of resources is not always a firm.

Is this the process of "metamorphosis" of the firm that Penrose referred to in TGF and in her later writings (Penrose and Pitelis 2009, p. 241)? She was concerned that as firms expanded, they might untangle and turn into something different, like a caterpillar turns into a butterfly. Her fear was that her reasoning would then no longer apply.

This analogy, I feel, overstates the case for change. The process of governing resources is not different between a firm and an alliance – just the tools are used differently. Ownership and control are used to manage resources in firms, and relational contracts do that in alliances (Gomes-Casseres 2015). Both types of organizations obey common principles. Both pool resources to compete and use administration to manage the complementarities among resources.

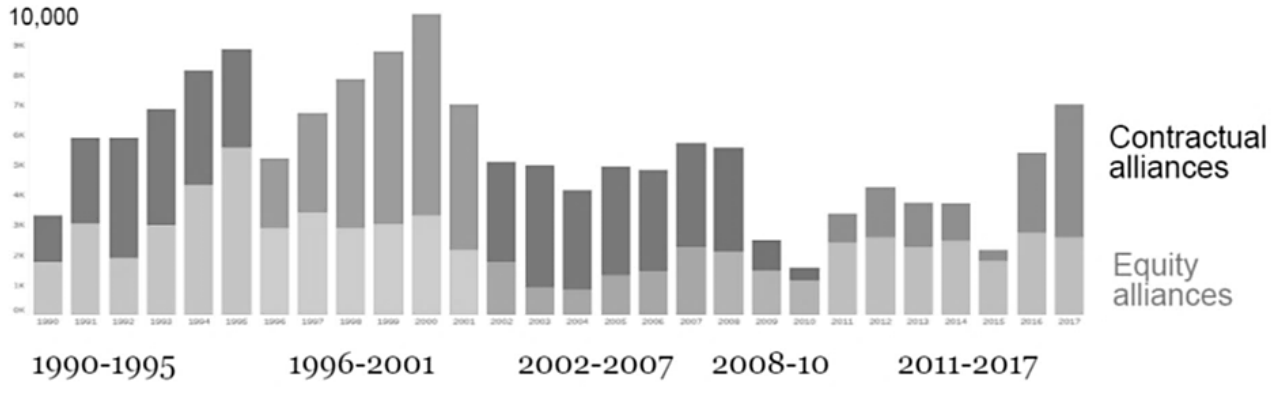
The firm, empirically or as a concept, is not becoming something else. But there are now more ways to do what the firm does so well. Edith Penrose provided us with a template of what the firm does, based on careful observation in a traditional industry. We have extended that template here to analyze new industries and newly popular forms of organization that she could only glimpse in her final years.

* * * * *

Figure 1
Updating Penrose in two dimensions

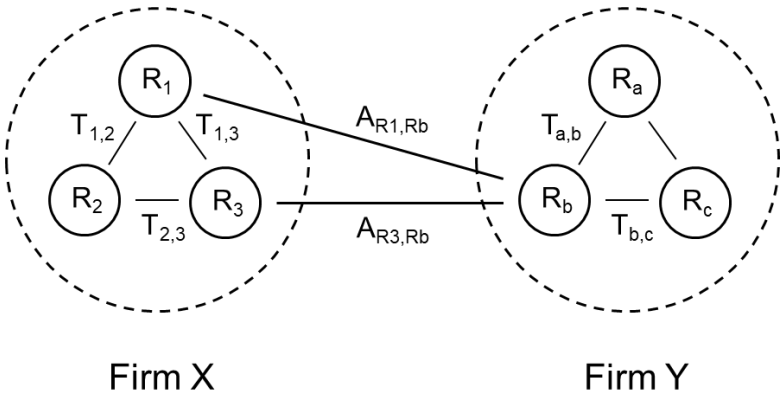
New thinking in economics	Section 3: Extension of original Penrose model with new theories of the firm and economics of contracting	Section 4: Application of extended-Penrose model to new firms and industries
Mid-20th century thinking in economics	Section 1: Original Penrose model (Penrose and Pitelis 2009; Penrose 1960)	Section 2: Application of original Penrose model to new firms and industries
	Mid-20th century firms and industries	**New firms and industries**

Figure 2
Rate of formation of alliances, 1990-2017
(Number of new deals annually, worldwide, as reported by Thomson Reuters)



Source: Compiled by Ben Gomes-Casseres and PwC from Thomson Reuters data.

Figure 3
Governance of resources inside and between firms in an extended Penrose model



R = Resources

T = Transactions, governed by administration

A = Alliances, governing incomplete contract

- - - - - = Firm boundaries

Table 1

Financial measures for Hercules and New Economy firms
(in billion 2019 US$)

	Selected financials				Financial ratios				
Column No.	1	2	3	4	5	6	7	8	9
	Market Cap ($ Billion) (A)	Sales or Revenues ($ Billion) (B)	Total Assets ($ Billion) (C)	Employees (D)	Capital to labor ratio (=C/D)	Price to book ratio (=A/C)	Market value per empl. (=A/D)	Sales per empl. (=B/D)	Yearly revenue growth since 2010 (***)
1960									
Hercules (*)	$4.5	$2.5	$1.5	11,000	$ 136	3.0	$ 409	$ 227	5%
2018/2019									
Ashland (**)	$4.7	$3.7	$3.2	6,500	$ 492	1.5	$ 723	$ 569	-5%
Facebook	$520	$60	$120	40,000	$ 3,000	4.3	$ 13,000	$ 1,500	46%
Amazon	$860	$230	$190	650,000	$ 292	4.5	$ 1,323	$ 354	24%
Google	$850	$135	$250	105,000	$ 2,381	3.4	$ 8,095	$ 1,286	19%
Apple	$1,000	$265	$320	120,000	$ 2,667	3.1	$ 8,333	$ 2,208	17%
Microsoft	$1,000	$125	$285	144,000	$ 1,979	3.5	$ 6,944	$ 868	8%
Intel	$230	$70	$130	110,000	$ 1,182	1.8	$ 2,091	$ 636	5%
eBay	$32	$11	$20	14,000	$ 1,429	1.6	$ 2,286	$ 786	2%

(*) Hercules assets and employees are from Penrose (1960); data for market capitalization and sales are from "Hercules Powder Company Set Sales and Profit Marks in 1959," NYT, January 26, 1960. All Hercules financial data are inflated to 2019 dollars.

(**) Ashland Global Holdings acquired Hercules Inc. in 2008 and in 2019 was a mid-size company in the chemical industry.

(***) 2010 revenues used in this calculation are not shown. Hercules's 1960 estimate is from Penrose (1960).

Sources: Financial statements of the companies, other than as noted above.

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