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Distributed dynamic capabilities in South Africa's mineral resource-finance network

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1. Introduction

In this analysis, we examine dynamic capabilities in a distributed governance system. This perspective is distinct as it breaks from the dynamic capabilities' association with the firm as the primary agent. We apply this concept of distributed dynamic capabilities to three case studies on innovation in South Africa's mineral industries spanning 100 years. Our analysis shows dynamic capabilities provide an important analytical lens to understanding the role of mineral resource-based economic development. It also suggests a distributed dynamic capabilities approach may offer significant insights about technology-based competitive advantages under collectively coordinated environments.

The importance of mining-finance groups to South Africa's economic development is well established.[1] Those conglomerates brought diverse capabilities together to build a range of vertically and horizontally integrated businesses. Beginning in the 1980's, South Africa reflected on its economic development legacy as it began a transition to democratic rule [28]. In that context, there arose increasing recognition that beyond the mining-finance groups there existed a distinct coordination system built around its mineral industries, but spanning agents across the State and private sector.[2] However, those perspectives tended to focus on its features as a system of accumulation rather than a feature of higher-level organizational coherence. In this analysis, we view that network, which spans the mining-finance groups, State-owned mineral-based enterprises, and parts of the State itself as forming a unique collectively coordinated governance structure,[3] which we call South Africa's mineral resource-finance network (MRFN). Owing to the long history of mineral industries in South Africa's economic development we can explore the evolution of this network's distributed dynamic capabilities across three cases where critical new technologies and market capabilities were developed during a century.

Distributed dynamic capabilities in South Africa's MRFN thereby provides a useful context to reflect on the nature of the organization within the dynamic capabilities approach more generally. Examining a dynamic collaborative capability within a collectively governed networked organization distinguishes this analysis from others in the literature where collaboration has been viewed as means to combine resources across organizational boundaries,[4] rather than create them within the organization. Through each case study we provide evidence that the high-level collaboration generated from the MRFN meets the criteria of a dynamic capability. As such, the dynamic capabilities approach is held to provide important insights about the pattern of economic growth where resource-based sectors create opportunities for learning in production of some goods and services rather than others.[5]

The remainder of this analysis is set out as follows, after elaborating on our analytical approach we turn to the first case study which examines the emergence of distributed dynamic capabilities on the kimberlite diamond pipes at Kimberley. The paper then

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[1] See for example: [29,46].

[2] Bill Freund provides historical context for this approach [28], which includes Hobart Houghton's conceptualization of a mineral revolution akin to W.W. Rostow's modernization paradigm [43,45,80], through Martin Legassick's analysis gold mining in the labor control system [55], and on to Fine and Rustomjee's concept of the Minerals Energy Complex (MEC) [24].

[3] In this regard, we follow Walter Powell in holding collective coordination as a third dimension to the market-hierarchy continuum [74]. However, we adopt Streeck and Schmitter's andHamilton and Feenstra's perspective and assume collective governance dominates [87,31], but coexists with market and hierarchical coordination rather than excluding them.

[4] See for example [2,3,60,68,71].

[5] The distinct opportunities that certain industries afford is a focus of the product space literature, [34–37,40]. For a contemporary application of this approach in South Africa see: [33,38].

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traces how those capabilities evolved to create the technology needed to exploit the vast gold resources discovered on the Witwatersrand gold fields. The final case study describes how distributed dynamic capabilities facilitated the adaptation and transfer of technologies along with an innovative financial structure to create a uniquely South African oil-from-coal technology. Implications in terms of the dynamic capabilities approach and South Africa's mineral-resourced based economic growth are then reviewed in the conclusion.

2. Analytical approach

Dynamic capabilities is fundamentally associated with Coase's notion of the firm as the primary and efficient agent [14]. This is clear throughout most of the literature where a dynamic capability is defined as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments [92,93,90]. Nonetheless, we contend that it is appropriately applied to a collectively governed network organization as well. These “distributed dynamic capabilities” as we call them retain the fundamental features of dynamic capabilities.

Teece et al. highlight that dynamic capabilities were conceptualized to explain what type of strategic management is needed for a firm to achieve and sustain competitive advantage [93]. Dynamic capabilities differentiate firms with the ability to survive and compete in periods of rapid and disruptive change from those firms that lose competitive advantage in those environments. As such, dynamic capabilities refer to the capacity of an organization to purposefully create, extend, or modify its resource base in the face of strong uncertainty. These are distinct from an organization's operational capabilities, which pertain to the current operations of an organization [39]. An environment of rapid and disruptive change is therefore a necessary condition for application of the dynamic capabilities approach. Therefore, each of our case studies begins with a subsection describing the rapid disruptive change, or deep uncertainty, it involves.

Organizational agility and strategy are key to the application of dynamic capabilities [90]. This combination of agility and strategy holds equally true in our analysis of the application of distributed dynamic capabilities, except that rather than residing in a firm the capabilities reside across the South African MRFN. Our case study methodology provides context that establishes the complex and systematic nature of distributed dynamic capabilities. In describing these in each case study, emphasis is given to their extraordinary nature and how they are distinct from ordinary capabilities that would perpetuate relatively static operating environments. In so doing we provide evidence that these distributed dynamic capabilities are akin to dynamic capabilities in the firm and are more than just ad hoc adjustments in the face of uncertainty with a favorable competitive outcome [21,110].

The historical structure of our case study approach also allows us to examine the socioeconomic process of these capabilities' development and change. In so doing our cases aspire to support Wadhwani and Jones' call to apply historical research to better frame understanding about the relationship between capabilities' development and the process of dynamic change [104]. Therefore, we conclude each of our case studies with a subsection devoted to an examination of the evolution of the distributed dynamic capabilities.

3. The kimberlite diamond pipes

3.1. Deep uncertainty in the Kimberley diamond fields

The pursuit of mineral wealth has been an important force in European exploration and international economic expansion over the past 500 years [65]. In southern Africa, the first significant mineral rush occurred in the 1850 s at the Namaqualand copper deposits, but the legacy of those deposits was muted [85]. It was not until the late-1860s when the Kimberley diamond fields were developed that an enduring Southern Africa's mineral-finance network emerged with distributed dynamic capabilities that facilitated broader economic development impacts. While there were an array of benefits and threats to Kimberley's establishment, the most important were associated with challenges to attract investment capital that could transform the diamond deposits' ownership structure and thereby the diamond industry's value chain.

In 1866, the ‘Eureka’ diamond was discovered on the banks of the Orange River. Despite initial skepticism about the geology of the deposits, further discoveries led to a full-scale rush for alluvial diamonds by 1869. These alluvial diggings were typically mined by a claim holder and assisted by local Africans in the digging and sorting of the diamond bearing soil. The alluvial deposits were quickly cleared and late in 1870 activity at the alluvial diggings rapidly declined.

However, early in 1870 the first non-alluvial igneous diamond pipes were discovered.[6] Diamond pipes are volcanic conduits that transport geologic material from deep in the earth to the surface. The discovery of these igneous diamond deposits around Kimberly marked an entirely new era of diamond mining. By 1871 mining on the ‘dry-diggings’ centered around four diamond pipes: Kimberley, DeBeers, Bultfontein, and Dutoitspan. The diamond deposits from these four pipes varied, but together their quantity and quality dramatically increased and transformed the international supply of diamonds. Previously, diamonds had been the purview of royalty and the extremely wealthy, but with the emergent supply of diamonds from the Kimberley deposits the potential to own one of these gems expanded dramatically [12, 29,66,107].

The diamond bearing pipes were relatively small although they continued to substantial depths. In 1872, the combined area mined at the Kimberley and DeBeers pipes encompassed 12.8 hectare (ha), 6 ha at Dutoitspan and 3.2 ha at Bultfontein. Given this small area and great quantity of diamonds, it became apparent early on that if mining operations were consolidated, the diamond miners' influence over the diamond industry's value chain would be greatly strengthened. If consolidation was realized, the largest potential losers were the European diamond merchants. However, there were several challenges facing a consolidation of diamond mining on the Kimberley fields. The claim ownership structure inherited from the alluvial deposits meant that initially each claim was just 2.9 square meters, only individuals could own a claim, no individual could own more than two claims and the owner forfeited their claim if it was inactive for eight consecutive days. These restrictions and the geology of the deposits quickly led to a situation where many individuals were mining a small area to greater and greater depths [107]). By the mid-1870s production problems were occurring at all four pipes because of the general depth and retention of single claims as the unit of production. The multitude of distinct and increasingly deep mining operations on the Kimberley pipe were originally accessed by an elaborate roadway scaffolding, but by 1872 their collapse in places necessitated replacement by a haulage system with wires emanating in a spider like fashion to the edge of the pit which is illustrated in Fig. 1.

In addition to just accessing their claim, the small nature and

[6] This diamond bearing igneous rock is called kimberlite after the city of Kimberley, which formed in the early 1870s around the mines. Currently, kimberlite is the main source of diamonds, but only a minority of kimberlite pipes bear diamonds, and only a fraction of those are economic enough to mine.