

Article

Response to Economic Shocks: An Organizational Fit Perspective

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The outcome of firm choices is better understood when viewed through a contingency framework. By treating prior organizational choices of geographic and vertical scope as a bundle, I propose that fit drives whether these seemingly independent choices align with each other. The recent shortage in the chip industry provides a context to evaluate whether expansion of fabrication facilities enhance (or diminish) the overall impact of the bundle of choices. Using examples of leading firms in the industry, I help frame an argument that may provide insight into why some firms' new fabrication location choices may be more optimal than others.

INTRODUCTION

Scholars, corporate executives, and policy makers have noted in the past several decades the rise in the global expansion of MNEs' value chain activities, in terms of both production and trade. The Asian Development Bank's data suggests that the activity peaked in 2010 and has remained relatively stable in the past decade. That said, research suggests that the decision to globalize value chains is not an unmixed blessing. On one hand, in choosing to place activities in different locations, MNEs can create value. Geographic distribution offers advantages such as access to markets, institutions and resources that may be novel, or offer lower cost. On the other hand, coordinating activities across locations, whether within or across the value chain, is challenging (Singh, 2008). Thus, consequences of the global expansion of value chains may be nuanced; and our understanding remains limited. I suggest a contingency framework to evaluate the outcomes of value chain globalization decisions, especially in the context of an economic shock.

Implicit in the decision to geographically distribute value chain activities, are two distinct choices. One is the choice to engage in certain value chain activities (or not). This represents the firm's vertical scope, i.e., whether the firm is vertically integrated or vertically specialized. The second choice pertains to geographically distribute value chain activities, which is the overall geographic scope of the firm. In considering vertical and geographic scope simultaneously, I emphasize that the implications of organizational choices need to be evaluated contextually to see whether such responses reinforce (or not) other choices. Organizational choices that are not aligned may hinder firm

performance in the long run. In applying this contingency approach, I use the construct of a *bundle of choices* to evaluate firm responses.

I consider the pandemic-driven shock in the semiconductor chip industry, along with examples of firms' responses to illustrate the idea. The antecedents of the supply shortage due to the COVID-19 pandemic resulted in both increased demand and a simultaneous decrease in supply. Demand for work-from-home technologies like PCs, tablets and webcams soared beyond the semiconductor industry's ability to supply, made worse by a range of products extending from baby monitors to dishwashers to LED light fixtures, game consoles, graphic cards, and TVs that people stuck at home were buying in record numbers. This supply-demand gap was exacerbated by the winter storm in Texas that affected chip manufacturing, along with a fire in the facility of a major Japanese chipmaker.

With the shortage not expected to improve in the short term, organizations that use semiconductor chips in their products have been forced to commit to long-term adjustments. Auto makers, the first to be hit by the shortage, worked to redesign vehicles to include fewer chips. Other firms took steps in chip development facilities to reduce dependence on chip makers. This shortage is so significant that the industry experienced a 20% increase in semiconductor chip prices in the second half of 2021 (Jie, Yang, & Kubota, 2021).

SEMICONDUCTOR INDUSTRY

The demand gap provides both an opportunity and a challenge for chipmakers as they make significant investments to ramp up capacity in upgraded technology and improve

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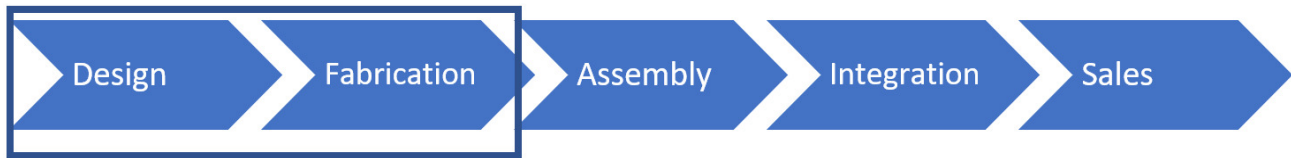


Figure 1. Semiconductor value chain

their current capacity utilization. [Figure 1](#) provides an illustration of the Semiconductor Industry Association's (SIA) depiction of value chain activities in the industry.

Within the semiconductor industry, firms are categorized by the nature of their value creating activities. *Fabless* organizations specialize in chip design. Vertically integrated firms, or *integrated device manufacturers* (IDM), engage in both design and manufacturing of chips. *Foundries* specialize in manufacturing (fabrication). Fabless firms rely on contract manufacturing with foundries to produce their designs. I refer to IDMs as vertically integrated as they engage in both design and fabrication, while foundries as vertically specialized as they engage only in fabrication. While the semiconductor value chain extends beyond design and fabrication, the comparison in vertical scope to just these two stages is appropriate since the focus is on organizational response in ramping up fabrication capacity.

During the industry's first few decades of the leading companies such as IBM and AT&T were fully integrated (Steinmueller & Langlois, 1999). In the late 1950s, *merchant manufacturers* entered the industry followed by *specialized equipment manufacturing* companies in the 1960s. Finally in the 1980s and 1990s, supported by open standards in personal computers, *fabless* semiconductor firms joined, targeting PCs and communications applications (Macher, Mowery, & Simcoe, 2010).

Considering geographic dispersion since the 1990s, there has been growing concentration of manufacturing activity in south-east Asia; Taiwan accounts for 65% of contract-manufactured chips, including capacity in the high-end range (Jie, Yang, & Fitch, 2021). The SIA predicts US share of global chip manufacturing to be down from 40% in the early 90s, to 10% by 2030. On the other hand, fabless firms dispersed globally, are largely concentrated in clusters such as Silicon Valley, Austin, in the US. From a demand perspective, US, Korea, and Japan account for 80% of global semiconductor sales in 2020.

In response to the global chip shortage, IDMs and foundries have announced new fabrication facilities. Samsung announced a \$17 billion plant in Taylor, Texas; Intel, a packaging fab in Malaysia, and over hundred billion dollars in manufacturing fabs in Ohio and Germany. Taiwan Semiconductor Manufacturing Company (TSMC), the largest foundry in the world, is committed to a gigantic facility in Arizona. The industry spent \$146 billion in new production facilities in 2021 alone; 60 % of this is attributed to Intel, Samsung and TSMC (Shead, 2022). This leads to the question: *How consistent are decisions by IDMs and foundries to geographically expand fabrication, with their prior decisions?*

I propose a framework to evaluate the consistency of the geographic expansion decision with the vertical scope decision (IDM vs foundry). This approach does not delve into the antecedents of either the IDM/foundry choice, or the individual location choice. Instead, I focus on the consequences of these choices, which I treat as a bundle. Sirmon et. al suggest "possessing resources alone does not guarantee the development of competitive advantage; instead, resources must be accumulated, bundled and leveraged, meaning that the full value of resources for creating competitive advantage is realized only when resources are managed effectively" (2011: 1391). The bundling of choices provides an opportunity to explore whether they reinforce or mitigate each other. That said, organizational fit is only one of several factors driving performance such as geopolitical issues (US-China tensions), incentives that countries provide to firms, proximity of application markets, proximity to buyers, among others. A detailed set of these drivers including their trade-offs would provide for a complete analysis of long-term organizational performance. These issues, however, are beyond the scope of this paper.

GLOBAL EXPANSION AS A RESPONSE TO ECONOMIC SHOCK

Prior research in IB suggests that multinational firms expand geographically to access resources unique to locations, institutions, and economic actors. The semiconductor industry is known to exhibit agglomeration benefits, and geographic expansion is driven by access to local industry specific resources. In addition, uncertainty in the fabrication process means R&D activities occur both upstream in design and downstream in the fabrication phases (West & Iansiti, 2003).

IDMs can share knowledge across activity domains as employees are able to learn firm specific processes via organizational dialog (Monteverde, 1995). Such knowledge sharing can be utilized so that downstream can alert upstream, and vice-versa, of specific needs and problems. This reduces the cost of knowledge-transfer while providing the setting to iterate problem-solving across activities. Foundries' access to a wide variety of knowledge via collaborations with alliance partners, however, is limited by the scope and nature of the alliance. Thus, IDMs more than foundries, are likely to have access to a wider variety of internal knowledge.

Global distribution of chip fabrication has surged in the last two decades. Since globalization of R&D activity is driven by access to knowledge from different locations

Table 1. Knowledge and organizational scope

	IDM	Foundry
Range of internal knowledge	Integration of design and fabrication allows design and process engineers to share and access a wide range of knowledge	Specialization in fabrication alone implies access to more limited internal knowledge.
Need to access external knowledge	Fewer incentives to seek knowledge outside firm boundaries	More outward-looking to complement internal knowledge
Making sense of external knowledge	Greater ability to relate external knowledge to broader internal knowledge base	Ability to relate external knowledge to internal is limited by scope of only fabrication-specialized knowledge
Geographic expansion of fabrication	Increasing organizational complexity increases the challenge in making sense of external knowledge	Increases organizational complexity but allows for increased ability to access external knowledge

(Almeida, 1996), firms must be able to benefit from such local knowledge resources. This requires the capability to absorb new knowledge by relating incoming knowledge to its own knowledge base. As IDMs have a broader repository of knowledge, the likelihood of making sense of external knowledge in the context of internal routines and processes is higher than in foundries which are limited to fabrication-focused internal knowledge. While knowledge flows disproportionately from firms with superior capability to those with inferior capability (Shaver & Flyer, 2000), IDMs are *more* likely than foundries, to be able to utilize locally available external knowledge.

The very attribute of IDMs that gives them an advantage in sharing knowledge between activities may not extend to external knowledge. Integration of design and fabrication means that employees of IDMs may be more invested in tailoring their knowledge at the design stage to fit process requirements in fabrication. This conformity means that prior commitments by design or fabrication stages will influence and limit other stage choices. A tightly coupled system makes seeking knowledge from external sources difficult (Celo, Nebus, & Wang, 2018). Employees in IDMs focus more on internal activities and reduce effort towards capturing external knowledge. Thus, the expanded repository of systems and routines of knowledge sharing may be the very reason why IDMs are *less* likely to look outside for resources.

As shown in [Table 1](#), organizations face a trade-off between dependence on external knowledge and ability to make sense of external knowledge. The impact of this trade-off depends on the vertical scope of the firm. Foundries, relative to IDMs, have a *greater need* for external resources but a *more limited ability* to make sense of external knowledge as it relates to its own resources. The reverse is true for IDMs.

In addition, with geographic expansion of fabrication facilities, IDMs face greater complexity which impact their ability to make sense of external knowledge. Increased coordination costs associated with geographic expansion of value chain activities in IDMs not only make it challenging to make sense of additional external knowledge, but also reduce their ability to fully search for internal knowledge

that is spatially distant. On the other hand, with increasing geographic expansion of fabrication facilities, foundries experience increased opportunities for access to external knowledge, an area of need for foundries.

Geographic expansion of fabrication facilities should ideally incorporate the need to align the vertical and geographic scope of the firm. Depending on how well these seemingly independent choices align with each other may prove to be critical in a firm's ability to maximize the potential of its investment in the new facility. Based on [Table 1](#), IDMs may be better served in limited geographic expansion of fabrication facilities. When IDMs do expand fabrication activity geographically, it could be for two reasons. Collocating fabrication with design centers would enhance the efficiency of organizational dialog. Also, collocating fabrication in areas of quality external knowledge resources such as clusters of semiconductor firms would increase incentive to seek external knowledge.

The implications for the trade-off in foundries are very different. Since foundries are relatively unconstrained by the need to conform to the design stage, they benefit from expanding to a wide variety of locations which provide them access to different types of knowledge, increasing the diversity of elements that they could choose from. Thus, foundries could be better served by greater dispersion of fabrication activity.

ORGANIZATIONAL FIT AND FABRICATION LOCATION DECISION

I use Intel, Samsung and TSMC as examples of firms, global in the scope and scale of their operations, that account for most new investments in fabrication facilities in 2021. I use current and planned locations of fabs to evaluate whether their choices maximize or constrain value extraction based on prior decisions of IDM or foundry. New facilities cost multiples of tens of billions of dollars (Bobrowsky, 2022) and firms expect to maximize the value from these investments.

Based on data available from the Semiconductor Trade and Equipment International (SEMI), along with recent press announcements, [Table 2](#) presents a list of existing

Table 2. Location of fabrication facilities(fabs)

Firm	City	State/Province	Country	Status
Intel	Dalian	Liaoning	China	Existing
	Leixlip	Kildare	Ireland	Existing
	Kiryat Gat	Southern District	Israel	Existing
	Chandler	AZ	US	New capacity at existing location; also design center
	Santa Clara	CA	US	Existing
	Colorado Springs	CO	US	Existing
	Hudson	MA	US	Existing
	Syracuse	NY	US	Existing
	Columbus	OH	US	Planned
	Germany	Germany	Europe	Planned
Samsung	Xian	Shaanxi	China	Existing; also design center
	Hwaseong	Gyeonggi	S. Korea	Existing; also design center
	Giheung	Gyeonggi	S. Korea	Existing
	Pyeongtae	Gyeonggi	S. Korea	Existing
	Suwon	Gyeonggi	S. Korea	Existing
	San Jose	CA	US	Existing; also design center
	Austin	TX	US	Existing; also design center
	Taylor	TX	US	Planned and announced 2021
	Nanjing	Jiangsu	China	Existing
	Shanghai	Shanghai	China	Existing
TSMC	Tainan	Southern Taiwan	Taiwan	Existing
	Hsinchu	Northern Taiwan	Taiwan	Existing
	Taichung	Central Taiwan	Taiwan	Existing
	Phoenix	AZ	US	Announced: 2021
	Camas	WA	US	Announced: 2021

and new facilities to briefly evaluate organizational fit using the bundle of choices perspective.

Both Samsung and Intel have multiple fab locations. Intel's fabs spans many more countries, but the majority of Samsung's fabs are concentrated in the same province in Korea. Additionally, the majority of Samsung's fabs are collocated with design to enhance coordination between design and fabrication. Thus, Samsung's vertical scope and geographic scope of fabrication appear to be more reinforcing of each other. In addition, Samsung's new fab planned at Texas is only 35 miles from Austin, one of the most vibrant semiconductor clusters globally. Intel's locations of Ohio and Germany are both distant from known clusters and existing design centers of the firm.

Unlike Samsung, TSMC is a foundry but with similar geographic footprint of fabrication activity. Since TSMC is not constrained by the need for conformity to design, it could benefit from access to wider variety of knowledge to increase its ability in sense making. For both Samsung and TSMC, future expansions listed in Table 2 are in semiconductor clusters, making their choices consistent with prior choices over time. Thus, Samsung's and TSMC's decisions on expanding geographic scope of fabs are aligned with their long-term strategy. Intel, based on logic presented in

Table 1, may have been better served in constraining the geographic expansion to existing design centers or one of many semiconductor clusters. It is noteworthy that the investments may be a push by Intel in response to losing its technological edge to rivals and ceding market share to industry peers in recent years.

CONCLUSION

The shortage of chip supply has had far-reaching consequences across a broad spectrum of the economy. In response, chip makers have invested significant capital to improve capacity utilization and in new fabs. These multi-billion-dollar investment responses to the pandemic related shock must be achieved in a short time and carry significant risk. Hence, it is imperative for scholars and practitioners to use the right tools and frameworks to evaluate the long-term implications of these pressure-induced responses. The organizational fit logic is one such perspective.

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BIOGRAPHICAL SKETCH

Nandini Lahiri is Associate Professor of Management at the Kogod School of Business at American University. Nandini's research lies at the intersection of international business, strategy, and innovation. Her research has been published

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