Entry diversion: Deterrence by diverting submarket entry

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Abstract
Research Summary: Going back to Bain (1956), strategy scholars have long recognized the importance of deterring entry for sustaining incumbents’ profits in an industry. We introduce a new mechanism, entry diversion, to better understand the empirical phenomenon of persistent firm entry in spite of investments in entry deterrence by incumbents in some industries. Entry diversion happens when preemptive strategic investments by incumbents decrease the expected future profits from a target submarket such that entrants choose to enter another submarket within the same industry. Empirical evidence from the global semiconductor manufacturing industry suggests that incumbents expand their capacities beyond demand growth, and that these investments effectively divert entry into other submarkets. Greenfield entrants are more responsive to entry diversion than incumbents.

Managerial Summary: Managers have long understood that deterring entry of new players into their industry could sustain their firms’ profits. In this article, we introduce a new mechanism, entry diversion, where the incumbent diverts potential entrants from its submarket toward other submarkets in the same industry. Entry
diversion happens when preemptive strategic investments
by incumbents decrease the expected future profits of the
entrant in a submarket of the industry such that the
entrant chooses not to enter the incumbent’s submarket.
Contrary to entry deterrence, new players will still enter
the industry but settle in different submarkets. Empirical
evidence from the global semiconductor manufacturing
industry suggests that incumbents expand their capacities
beyond demand growth, and that these investments effect-
tively divert entry into other submarkets.

**KEYWORDS**
entry deterrence, entry diversion, semiconductor manufacturing,
submarkets

### 1 | INTRODUCTION

Going back to Bain (1956), strategy scholars have long recognized the importance of deterring
entry for sustaining incumbents’ supernormal profits in an industry (Porter, 1980). Countless theo-
retical models have been developed and formalized about traditional entry deterrence, such as
advertising, limit pricing, excess capacity, minimum efficient scale, and absolute capital costs, to
explain how these barriers work and influence the (potential) entrant’s entry decision (Smiley,
1988). However, the persistence of entry into some industries, together with the sparse empirical
support for entry deterrence, has cast some doubt on the empirical relevance of many entry deter-
rence theories (Ellison & Ellison, 2011; Geroski, 1995; Gilbert, 1989; Lieberman, 1987a, 1987b,
1989; Scott-Morton, 2000; Seamans, 2013; Singh, Utton, & Waterson, 1998; Wilson, 1992).

There may be good reasons for the paucity of empirical evidence. Entry deterrence is difficult to identify empirically. If successful, no entry will be observed. Moreover, the cost of entry
dererrence may outweigh the benefits in many settings, and many of the theoretical models rely on very specific
assumptions that might not be met in many of the empirical environments that have been studied.

Refining our understanding of entry deterrence from the industry level to the submarket level can explain the simultaneous occurrence of entry deterrence efforts by incumbents and continued
entry at the industry level. Rather than deterring entrants from the industry entirely, incumb-

ent can divert them into entering other submarkets within the same industry. Such a view of
entry deterrence, we believe, matches the theory with the empirical observations, at least in
some industries. Entry persists but incumbents also protect their profit level in their submarket.
We call this process *entry diversion*.

The main idea behind our model is as follows. Ex ante investments in entry deterrence by
an incumbent in a submarket affect the entrant’s incentives from entering the incumbent’s

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1 Rates of new firm entry in the United States have declined over the past several decades, suggesting that industry-level bar-
riers may be rising in many industries (Council of Economic Advisers (CEA), 2016).
2 Entry deterrence is difficult to identify empirically. If successful, no entry will be observed. Moreover, the cost of entry
dererrence may outweigh the benefits in many settings, and many of the theoretical models rely on very specific
assumptions that might not be met in many of the empirical environments that have been studied.
3 Although there is no agreed upon definition, we define submarkets as specialized product clusters where the
interaction among the technologies they use, the product/services they offer, and the customer segments they target,
matters (Klepper & Thompson, 2006; Sutton, 1998; Uzunca, 2018). In a following section, we discuss how industry,
submarket, and local market are distinct from each other.
submarket and direct the entrant toward finding new areas of growth, in particular, entering other submarkets in the same industry (Dafny, 2005; Geroski, 1991; Seamans, 2013). As a result, entry deterrence does not need to deter entry into the industry. It might be sufficient to divert entry into other submarkets within the same industry. This may explain why, at the industry level, there is little empirical evidence for entry deterrence (Cookson, 2018) and why entry rates are hard to explain using conventional measures of profitability and entry barriers (Geroski, 1995: 430): Entry actually happens in different submarkets. Although this might seem a straightforward reclassification exercise where entry deterrence applies to the submarket-level rather than to the industry-level, we go one step further by showing the impact of submarket interdependencies on entry deterrence (Ethiraj & Zhou, 2019). Moreover, the strength of diversion depends on the relative costs of entering in one submarket compared to another submarket, that is, how connected different submarkets are (Kim & Kogut, 1996; Uzunca, 2018), and, on the type of entrants across submarkets (Helfat & Lieberman, 2002; Lieberman, 1987a).

Using a unique submarket- and plant (fab)-level panel dataset from the global semiconductor manufacturing industry between 1995 and 2015, we find consistent evidence for our entry diversion model. Threat of entry into a submarket by new entrants triggers a capacity expansion response by incumbents beyond the expected growth rate to reinforce their position in that submarket. These capacity expansions in turn increase actual entry into other submarkets, even after controlling for demand, industry characteristics, and submarket and year fixed effects. Capacity investments in one submarket, therefore, seem to affect entry in a different submarket. This result is consistent with entry diversion where entrants redirect their efforts toward different submarkets, rather than abandoning their industry entry attempt entirely. Consistent with our expectation, greenfield entrants are easier to divert than incumbent entrants as they enter with no constraining pre-developed production facilities and capabilities (Helfat & Lieberman, 2002; Klepper, 2002; Klepper & Simons, 2000). This finding is furthermore consistent with the strategic behavior of incumbents as they tend to accommodate greenfield entrants to a lesser extent than they accommodate each other in a submarket (Lieberman, 1987a; Thomas, 1999).

In overall, our main contribution is that entry diversion helps us understand better the empirical phenomenon of persistent firm entry in spite of investments by incumbents in entry deterrence. Entry diversion allows us to reinterpret how entry accommodation happens; that is, even when entry is accommodated into the industry, it might be diverted towards different submarkets. Researchers finding limited empirical evidence for entry deterrence at the industry level might be missing some underlying entry dynamics that take place at the submarket level. When one submarket deters entry, another might actually be attracting it, and these are not independent processes: entry deterrence might not be happening at the industry level, but at the submarket level.

2 | LITERATURE REVIEW AND BOUNDARY CONDITIONS

The concept of within industry mobility has a long intellectual history that goes back in the literature at least as far as Caves and Porter’s (1977) study on mobility barriers. In their seminal paper, Caves and Porter (1977) put forward that filling various niches in consumers’ preference

4Investments of incumbents in entry deterrence will be captured in a way similar to Lieberman (1987a, 1987b) where incumbents’ excess capacity investments deter entrants from entering a submarket.

5We define incumbent entrants as firms already active in the industry entering with a new or acquired production facility in a different submarket (cf. Simon, 2005).
space leaves less viable ones for entrants. In fact, although they do not develop the idea further, they explicitly mention entry diversion as follows:

“Firms in the queue are discouraged from entering the $i^{th}$ group, say, by an increase in that group’s investment in entry barriers. As prospects for entering the $i^{th}$ group shrivel, one effect is to divert attention toward the $j^{th}$. The shifting incentives for group entry thus provide one mechanism for the transfer of competitive forces from one group to another within an industry (p. 254–255).”

Although mobility barriers also seem to divert, the framing is different from entry diversion as the definitions of strategic groups and submarkets are fundamentally different. The former is based on grouping businesses based on their strategies, that is, their activities (Mascarenhas & Aaker, 1989). However, submarkets offer a deeper understanding of the intra-industry heterogeneity, both on the customer and technology sides (Sutton, 1998). Furthermore, and probably more importantly, the existence of mobility barriers not only protects incumbent firms from new entrants into the industry but also from entry from other groups (intergroup mobility). Therefore, mobility barriers imply group membership stability (Mascarenhas & Aaker, 1989; Porter, 1980). Entry diversion departs from strategic groups as it would stimulate substantial mobility between groups. Some incumbents might move to a different submarket as entry deterrence efforts in their original submarket increase.

Lieberman (1987a) analyzes excess capacity investments in the chemical industry and finds that incumbents in more concentrated submarkets respond more aggressively to new entry. He derives hypotheses from a formal model to compare incumbent reactions to entry by greenfield entrants and to expansion by other incumbents. Initially lumpy greenfield plants are announced—which take 2 years to complete—and then incumbents adjust their capacity with incremental expansions to accommodate these new plants—which take 1 year to complete. Lieberman finds an asymmetric response that incumbents in concentrated submarkets engage in “mobility-deterring” investments; they accommodate greenfield entrants to a lesser extent than they accommodate each other. We build on this by arguing that these capacity expansions will actually direct entry into other submarkets in the same industry. Similar to Lieberman (1987a), we capture the existence of strategic behavior of incumbents by comparing how greenfield and incumbent entrants respond differently to these capacity investments. Our contribution is to assess whether this response diverts actual entry into other submarkets.

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6One can find several such referrals, although mostly ad hoc, to the idea of entry diversion in the literature. Examples include Porter (1985: 486), “Entry may be terminated or a less ambitious target set, an outcome that has occurred in many industries,” and Geroski (1995: 436), “…it is a little difficult to reconcile high entry barriers with high entry rates, not least because entry barriers are commonly thought of as an obstacle which prevents firms from entering a market. If, however, barriers to entry are thought of as an obstacle which prevents new firms from surviving long in a market, then the data present less of a puzzle. In this alternate view, barriers to entry appear similar in character to costs of adjustment, and they are particularly pressing for those entrants who have only a limited time in which to prove themselves.”

7Gordon and Milne (1999) assert that although the dimensions chosen by researchers to define strategic groups vary subjectively, there is no subjectivity in what variable should define the submarket structure: pair-wise substitution of products. Porter (1979), for example, states that differences in firms’ competitive strategies, such as the level of vertical integration, the breadth of their product line, level of fixed costs, R&D and marketing expenses, and geographical markets they serve, do not impose differences on the product at all (p. 215). He then operationalizes strategic group membership by the relative size of a firm as large leaders and small followers (p. 220). This is a crucial distinction because entry diversion is based on entrants changing their focus to different product categories with different technologies and customers, not merely on firm strategies. Our research question highlights the effectiveness of entry deterrence, thus strategies per se will not be sufficient to divert entry.
The idea of diverting entry rather than completely deterring it into the industry has also been explored along the product characteristic and time dimensions. Eaton and Lipsey (1980) develop the idea that an incumbent or first mover in an industry can attempt to delay a potential new entrant into the industry by making preemptive and irreversible capacity expansion commitments. For these commitments to remain credible, they should be made intertemporally in certain frequencies because capital investments depreciate over time and lose their effect unless they are replenished. Similarly, an extensive theoretical and empirical literature on spatial preemption or product differentiation has examined product proliferation along the product characteristic’s dimension to deter entry or at least direct entrants into more distant varieties of the product to protect profits (Schmalensee, 1978).

3 | ENTRY DIVERSION

We base our model of entry diversion on the fact that previous literature has found limited empirical support for entry deterrence at the industry level (Cookson, 2018; Matsa, 2010). The majority of the findings, from advertising (Scott-Morton, 2000) to excess capacity (Lieberman, 1987a, 1987b), suggest that investments on entry deterring activities by incumbents are not effective. Moreover, there are studies that point out that empirical patterns do not always match what is predicted in theory (Kwoka & Batkeyev, 2019). The limited empirical support mainly comes from studies that investigate incumbent reactions to threat of entry identified in clever ways, such as the presence of Southwest Airlines in both endpoint airports (before it starts flying the route itself) (Goolsbee & Syverson, 2008), impending patent expirations (Ellison & Ellison, 2011), or entry plans of casinos (Cookson, 2017, 2018). Other related studies provide limited evidence for excess capacity being strategically used, for example, among hotels in the Texas lodging industry (Conlin & Kadiyali, 2006). Similarly, Masson and Shaanan (1986) state that excess capacity and limit pricing may be used to deter entry and cautiously conclude that their results “provide no evidence that oligopolies deliberately install excess capacity to deter entry.”

Scholars in the “new empirical industrial organization” tradition (Bresnahan, 1989) also conducted structural tests that model demand and supply as a function of firm strategies, prices, and advertising. Kadiyali (1996), for example, investigated the Fuji-Kodak rivalry and examined whether Fuji’s pre-entry and postentry periods displayed different market structure estimates in the U.S. photographic film industry. Kodak was the near-monopolist in the 1970s until it was compelled to accommodate Fuji’s successful entry in 1980. However, such an analysis, as Sudhir (2001: 45) posits, makes sense only when there are a few dominant products and dominant firms in the industry (see Coke-Pepsi rivalry studied by Gasmi, Laffont, and Vuong (1992) for another example).

A last source of the sparse empirical evidence for entry deterrence comes from surveys which base their findings on questions answered by managers for the existence and effectiveness of entry deterrence (Bunch & Smiley, 1992; Smiley, 1988). As is clear, much of the empirical evidence is indirect, and the extant literature implicitly or explicitly assumes that incentives

8In Lieberman’s (1987a) approach, entrants invest only in greenfield plants, we also allow entrants to enter by purchasing an existing plant.

9Studies investigating incumbents’ strategic responses to the threat of entry are richer and more nuanced than studies investigating whether these investments are strategic deterrents of actual entry (Conlin & Kadiyali, 2006; Kadiyali, 1996; Masson & Shaanan, 1986; Seamans, 2012). Our study focuses on the latter, that is, incumbent capacity investments affects actual entry into other submarkets.
to strategically deter entrants exist for firms that use various corporate actions that affect competition (Matsa, 2010).

To develop a model of entry deterrence that incorporates theoretical arguments of entry deterrence and empirical observations of persistent firm entry, we consider that every submarket attracts a queue of potential entrants (what Bain (1956) termed the “general condition of entry”). Entry typically entails an investment decision with some sunk cost (Cabral, 2012; Dixit & Shapiro, 1986; Tirole, 1988). Entrants first examine their options and then consider the incumbent firms that occupy their target submarket ex ante (Dafny, 2005; Ellison & Ellison, 2011; Lieberman, 1987b; Seamans, 2013). We focus here on preemptive strategic capacity investments by incumbents. Capacity investments by an incumbent in its submarket condition entrants’ incentives from entering the incumbent’s submarket and force the entrants to evaluate alternative areas of growth, such as entering other submarkets (Geroski, 1991). We call this process “entry diversion.” Entry diversion happens when potential entrants observe that the expected future profits from a target submarket are decreased by the presence of preemptive capacity investments by incumbents, and, as a result, the entrants choose to enter another submarket.

Entry diversion in its most elementary form operates as follows. Take two submarkets, i and j, with an existing incumbent in submarket i and submarket j has no incumbent. The incumbent in submarket i responds to the threat of entry into its submarket by expanding its capacity preemptively. This capacity expansion restricts residual demand for prospective entrants (Tirole, 1988). Entry diversion happens when preemptive investments by the incumbent in submarket i decrease entry into submarket i and direct entry toward submarket j. Therefore, an increase in the entry threshold due to the incumbent’s preemptive strategic investments in capacity (as a response to threat of entry) in submarket i will cause a decrease in actual entry into that submarket (deterrence), but will in turn result in an increase in entry into submarket j (diversion).

Obviously, incumbents within each submarket might have an incentive to divert potential entry away from their own submarket. Suppose now that both submarkets i and j have an existing incumbent firm, which are characterized as strategic actors. In that case, the incentive for each incumbent firm to deter or divert entry will depend on the expected profitability of entry and the (sunk) cost of entry across submarkets. Diverting entry implies that the incumbent in submarket i makes entry into its submarket less profitable to the potential entrant compared to entering into submarket j. Therefore, the cost of entry diversion for the incumbent in submarket i is defined as the loss of profits from reducing the entrant’s profits below the profits of its next best alternative—entering submarket j. In the case of symmetric submarkets, the cost of entry diversion is inversely related to the sunk cost of entry. The incumbent with lower costs of entry diversion will be able to outcompete the incumbent with higher costs of entry diversion.

10 Examples of ex ante entry deterrence can be found in the literature, such as limit pricing, excess capacity, and early technology adoption (Dafny, 2005; Ellison & Ellison, 2011; Seamans, 2013). A notable feature of this literature, as mentioned above, is that despite the significant degree of theoretical development, there is a lack of empirical studies about the incumbent’s ex ante actions in response to potential entrants (Gilbert, 1989; Lieberman, 1987b; Singh et al., 1998; Wilson, 1992).

11 If these capacity expansions make the incumbent more efficient at the same time, the effect on other incumbents and potential entrants is reinforced; but, this is not a necessary condition for entry deterrence.

12 A critical assumption in the early models of entry deterrence is that the incumbent can commit to this capacity (and production) expansion. Later models have relaxed this assumption. As a result, holding excess capacity is not a necessary condition for entry deterrence (Tirole, 1988).
This latter incumbent can then decide to deter entry from the industry entirely or accommodate entry into its submarket. As a result, entry will be diverted toward submarkets with higher costs of entry diversion.\textsuperscript{13}

The traditional entry deterrence literature aims at explaining how entry barriers can deter entry by setting potential entrants’ profit functions to zero, that is, decreasing their expected profits below their opportunity cost of the next best alternative, which is not entering the industry. Taking the “entry diversion” lens enriches this more limited view by decreasing entrants’ expected profits in one submarket below those in an alternative submarket. Here, it is explicitly assumed that firms prefer entering the industry over not entering; that is, the outside option is entering an alternative submarket. From the incumbent’s perspective, we argue that entry diversion is feasible because, in absolute terms, it will be less costly for an incumbent to divert than to deter entry. Thus, incumbents have more incentives to react aggressively to entry into their own submarket than to entry with a new product (i.e., a new submarket). Simply stated, because diverting entry between submarkets is less costly than deterring it from the industry entirely, incumbents might be better off by diverting entrants to other submarkets than by fully deterring them from entering the industry.\textsuperscript{14} Similarly, entrants will be better off entering other submarkets where entry is less costly, whereas expected future profits are higher, compared to staying out of the industry. As a result, deterrence efforts of incumbents might be less intense and, hence, more difficult to observe empirically. At the same time, entry into the industry will seem unaffected by any entry deterrence efforts by the incumbents.

3.1 Predictions

3.1.1 Entry diversion: incumbent’s decision and entrant’s response

In operationalizing entry diversion, we need to capture the \textit{ex ante} investments of incumbents; that is, incumbents should have invested credibly against the threat of entry into submarket \(i\), so that, due to this investment, actual entrants will be diverted to submarket \(j\). Thus, the first part of the chain of action predicted by our model involves incumbents reinforcing their position in a submarket in the presence of an entry threat. Such an increase in threat of entry into a submarket increases incumbents’ capacity expansion in that submarket.

As incumbents respond to the threat of entry by expanding their capacities preemptively, they leave less residual demand for an entrant (Tirole, 1988). Although these investments could deter entry—in a traditional way—into that submarket, our main argument is that at the same time these investments serve to divert entrants into other submarkets. We argue that incumbent

\textsuperscript{13}In reality these expected future profits can be based on many factors, some of them include projected market size and growth, competition, firm’s capabilities to add and appropriate value, and customer needs. In a simple formal model, differences in entry costs across submarkets are sufficient to trigger this result as the cost of entry deterrence by incumbents will then differ across submarkets.

\textsuperscript{14}The degree of substitutability between submarkets of diverted entrants and submarkets of diverting incumbents might affect incumbents’ incentives to choose to divert versus fully deter entry (Kim & Kogut, 1996). If submarkets are closely related to each other, that is, the intra-industry structure is more homogenous, then diverting entrants to these adjacent submarkets might not be an effective solution to incumbents’ concern of sustaining supernormal profits in their submarkets. In cases of high levels of substitutability or closeness between submarkets, incumbents might be better off choosing to fully deter entrants from the industry. In other words, the more homogeneous the intra-industry structure is, the less incentives incumbents will have to divert (as compared to deter) entry (see also Uzunca (2018)).
capacity expansion in a submarket (i.e., an increase in capacity in a focal submarket) has two consequences: (1) decrease the number of entrants into that submarket (the traditional entry deterrence argument), and (2) increase the number of entrants into other submarkets. Identifying this latter effect is a contribution to the literature on entry deterrence where the capacity dynamics in one submarket affect the entry dynamics in another submarket.

### 3.1.2 Greenfield versus incumbent entrants

To further our arguments for entry diversion, we also investigate the heterogeneity among entrants. Greenfield entrants are unconstrained by already developed capabilities (Helfat & Lieberman, 2002; Klepper, 2002; Klepper & Simons, 2000) and will be less restricted in their entry choices. Moreover, greenfield entrants might also be less knowledgeable about the future prospects of a market (such as demand forecast). On the contrary, incumbent entrants, that is, already active firms entering with a new or acquired production facility (cf. Simon, 2005), have already invested a significant amount of their resources in competences needed to serve one particular submarket (Uzunca, 2018). As they switch from one submarket to the other, they will be constrained by their already developed capabilities in the original submarket (Leonard-Barton, 1992; Tushman & Anderson, 1986) which will affect their choice of submarket to enter (Kim & Kogut, 1996). Furthermore, they might be better informed about the expectations of successful entry. Therefore, we expect the (sunk) entry cost of a greenfield entrant to be higher than the entry cost of an incumbent entrant in a submarket. The cost of entry diversion of greenfield entrants is, therefore, lower. As a result, we expect that greenfield entrants will be more responsive to entry diversion compared to incumbent entrants.

### 4 DEFINING SUBMARKETS

Carefully defining submarkets and measuring inter- and intra-industry heterogeneity is central for our study. Since their early empirical work, IO researchers tend to rely on more objective classification schemes such as Standard Industrial Classification (SIC) codes (Sharp, Bergh, & Li, 2013). However, many industries feature striking levels of product variety that belie their limited SIC codes (Bryce & Winter, 2009). Some related work that we build on uses “local markets;” however, these are also defined mostly by geographical boundaries. For example, Seamans (2013: 431) defines cable TV markets by the geographical boundary of the city in which the incumbent system is based. Goolsbee and Syverson, (2008: 1614) define passenger airlines routes by their two endpoint airports and look at “direct flights” on a route. Similarly, Dafny (2005: 526) defines hospital procedure markets as Health Service Areas as defined in the Dartmouth Atlas of Health Care (1996). Recently, this static and homogenous view has been challenged by the notion of submarkets (Klepper & Thompson, 2006; Sutton, 1998; Tong, 2009).

Submarket boundaries are not only a function of the distinct technical knowledge but

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15 Bryce and Winter (2009) argue that SIC codes provide biased measures for market definition because their hierarchical structure does not represent the closeness between product categories in terms of substitution and because they depend on judgments of the designers of the SIC system and are thus “subjective.” Likewise, Klepper and Thompson (2006: 875) state: “In empirical analysis we are accustomed to treating industries as homogeneous, although we are well aware that the way data are reported from industrial censuses typically lumps together a lot of diverse submarkets.”
may also derive from the demand environment, which represents heterogeneous and changing consumer needs (Adner & Levinthal, 2001; Uzunca, 2018). Depending on the empirical context, geographical boundaries might or might not be an important dimension affecting submarket boundaries.

Regarding the definition of submarkets, Sutton (1998) uses a cluster of products (p. 18), product groups (p. 101), and product categories (p. 474) as synonyms for submarkets. Buenstorf and Klepper (2010: 1564) define submarkets as “different product variants that appeal to different users and may also require different knowledge and methods to produce.” Bhaskarabhatla and Klepper (2014) define submarkets as “islands of activity that are insulated from the rest of the industry on both the demand and supply side.” Submarket boundaries are determined by identifying areas where within-group competition is much stronger than across group competition.

On the empirical side, differentiating firms along these many dimensions is not an easy task. Researchers need to make assumptions to define submarkets. For example, Bhaskarabhatla and Klepper (2014) decide on submarkets in the U.S. laser industry as follows: “The material determines the wavelength of the laser light, which in turn dictates the applications serviced by a laser (p. 1384).” They add: “Ideally, to test our implications, we would define submarkets based on a rich set of product attributes but we base our definition on wavelengths or clusters of wavelengths due to data limitations (p. 1392).” However, a straightforward critique could raise the following question: Is wavelength enough to demarcate all laser submarkets? Thus, theoretically defining submarkets is easier than empirically defining submarkets, and it is important to make sure that both supply and demand considerations are integrated in the definition. In that sense, key characteristics for the customer (for example, speed and resolution of a printer or power and wavelength of a laser product, etc.) determine different submarkets in an industry (de Figueiredo & Silverman, 2007; Klepper & Thompson, 2006). Attractiveness of a submarket for entrants is determined by the valuation of these characteristics by consumers (i.e., demand) and how these opportunities can be exploited by individual firms (i.e., supply). Different submarkets require different firm competences (Uzunca, 2018); thus, different types of firms might choose to enter or avoid entering different submarkets (Argyres, Bigelow, & Nickerson, 2015; Helfat & Lieberman, 2002).

5 EMPIRICAL CONTEXT AND DATA

In this section, we describe our setting—the global semiconductor manufacturing industry—and the quantitative data, supported by consultation from industry experts. Because of its diversity and segmented structure in terms of manufacturing technologies (such as bipolar, MOS, CMOS, BICMOS) and products with different key functionalities (such as analog, digital, power semiconductors, signal processing, optoelectronics), as well as capacity and investment levels,

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16Industry evolution and technological change have greatly reduced the utility of many traditional industry definitions, blurring which criteria will be critical for definition in the future, or what technology or product/service dimensions will be at the center of the reconstituted industry. For example, the replacement of SIC with NAICS reflected the change from 20th century manufacturing industries to 21st century service and professional industry structures. Although almost half (459) of industries represented manufacturing in the old SIC, 250 of 358 new industries in the NAICS are service industries. The ongoing restructuring of the inter- and intra-industry boundaries suggests a need to change our approach to industry definitions we use in our methods and theoretical models.
sales, entry, and exit, the industry provides a fruitful context with substantial variation to perform our empirical analysis.

Manufacturing semiconductors ranks among the most technologically complex and capital-intensive processes. It comprises hundreds of operations of processing silicon wafers into semiconductor chips. Depending on the size of the wafer and the chip geometry, any number from tens to tens of thousands of dies can be processed on a wafer. Increasing complexity results from higher wafer sizes and smaller technology nodes (geometries). Typically, the transition from one node to the next is costly; however, this cost is exceedingly compensated by the increase in how many transistors can fit on a given die, that is, the cost per transistor falls substantially. Moore’s law is based on this economic progression, and it is this exact process which made feasible today’s small mobile devices that cost only a couple of hundred dollars and deliver more computing power than the mainframes of 1980s which cost millions of dollars. These requirements continuously force semiconductor fabrication facilities, that is,fabs, to give priority to rapid and aggressive adoption of new technologies and scale-up production by increasing their capacities continuously; failing to do so would result in loss of market share.

The semiconductor manufacturing industry fits well with our model because semiconductors can easily be structured into submarkets (Sutton, 1998: 358). Along the dimensions of process technologies on the one hand, and key functionalities of products on the other hand, we can distinguish between submarkets, such as analog, discrete, MEMS, memory chips, and logic chips. These can be further fragmented into an array of specialized “secondary” submarkets, such as mixed signal and linear chips for analog products; light-emitting diodes (LEDs), thyristors, and transistors for discrete products; DRAMs and Flash chips for memory products; and digital signal processing (DSP) chips, microprocessors (MPUs), and microcontrollers (MCUs) for logic product families.

Semiconductor products may be viewed as a compressed group of electrical functions, where a function could be a memory bit or a logic gate (Leachman & Leachman, 1999). An industry expert noted: “The nature of the function determines which types of applications the chip will serve, so the technologies, process steps, and manufacturing tools that are required for producing, for instance, MEMS chips and memory chips are completely different.” Semiconductor submarkets also present demand side heterogeneity in offering different key functionalities—that is, customer benefits derived from product features. For example, data processing devices (e.g., PCs, notebooks, servers) typically use MPUs, DRAM, SRAM, and, more recently, NAND Flash memory chips, whereas sensors (MEMS), MCUs, DSPs, power, and analog chips can be found in modern automobiles. Another industry expert noted: “...the design and marketing skills required for different businesses are very different. A memory company cannot become a logic company or a MEMS company overnight.” These properties of semiconductor submarkets fit our previous definition for submarkets. The hierarchical structure of submarkets in the industry can be seen in Figure 1.

17Wafer diameters:

100 mm (4”), 125 mm (5”), 150 mm (6”), 200 mm (8”), 300 mm (12”), and 450 mm (18”). Larger wafer diameters come with costly equipment and machinery for fabs; however, they also allow firms to produce more chips per wafer, that is, higher economies of scale are obtained.

18Moore’s law states that the number of transistors on ICs doubles approximately every 2 years.

19MEMS stand for microelectromechanical systems, which are miniaturized sensors with extreme reliability, such as accelerometers and pressure sensors, which have applications in smartphones, inkjet printers, automobiles, projectors, and microphones. They can be camera parts, such as movement and direction sensors for mobile phones or accelerometers that are incorporated into airbags.
5.1 | Data

The core source of data is the Semiconductor Equipment and Materials International (SEMI™)'s World Fab Watch (WFW) dataset for the 1995–2015 period. These panel data of more than 1,000 fabs per year worldwide consist of numerous variables, such as product/class (e.g., Analog, Discrete, Logic, MEMS, and Memory), technologies, products, geometries, wafer sizes, fab capacities, equipment, and construction costs. The initial data included 23,286 fab-year observations.

Because reliably following all the product categories within a fab over time is practically impossible, SEMI™ focuses on the two major product types of each fab (e.g., Discrete/LED or Logic/MPU). The product/class variable is composed of a maximum of 37 different types of product classes (see Table 1). From these product classes, we also allocated foundries to their corresponding submarkets because the distinguishing feature of a foundry compared to a fab of an integrated firm such as Intel is its business model—contract manufacturing—rather than the technologies or markets it focuses on. Foundries are contract-based manufacturers, such as Taiwan Semiconductor Manufacturing Company (TSMC), which focuses solely on manufacturing and which does not design chips. They emerged during the transformation of the industry due to the fact that vertical integration was no longer required (Dibiaggio, 2007; Kapoor, 2013; Linden & Somaya, 2003; Macher & Mowery, 2004). For example, as made-to-order chip producers, foundries might produce memory chips or logic chips; therefore, we allocated them to these submarkets accordingly.

Following our conversations with industry experts, we decided to exclude EPI, R&D, and Pilot fabs from the analysis. EPI is not a submarket but rather a specialized material—a nearly perfect crystalline thin layer on wafers—that is required for some devices. EPI fabs therefore do not produce devices but instead deposit this layer for their customers, that is, device makers, and send the wafer to them to fabricate the device. We also excluded R&D fabs and pilot fabs, as these fabs do not necessarily belong to a certain submarket; they are for early development and production, and their capacity impact is not substantial. Accordingly, we removed 389 EPI, 790 pilot, 1,999 R&D, and 504 R&D-Pilot fab-year observations. In total, the data include five submarkets, namely, analog, discrete, MEMS, logic, and memory, and 19,257 fab-year observations.

**FIGURE 1** Structure of submarkets in the semiconductor manufacturing industry
observations. As our entry diversion model covers submarket-level predictions, once we aggregated data into submarket level, these yield 105 submarket-year observations.

Although SEMI™ tracks important supply-side information used in semiconductor manufacturing, we utilized the VLSI Research and the Yole Développement™ data on worldwide semiconductor sales per submarket-year. This allows us to control for demand growth as an important alternative explanation for entry into one particular submarket (Scott-Morton, 2000).

5.2 | Descriptive statistics and patterns in the data

In this section, we first provide detailed descriptive evidence before we present the results of the regression analyses. Semiconductor manufacturing is clearly an industry where “size matters.” Increased incumbent capacity serves as a commitment to threaten entrants by reducing residual demand. In Figure 2, we map submarkets by using the important determinants of economies of scale, that is, “geometry” or “die size” in microns, and “wafer diameter” in inches.20

| Initial submarkets          | After organizing          | Main submarkets          |
|-----------------------------|---------------------------|--------------------------|
| Analog/linear               | Logic/Flash               | Analog/linear            | Logic/System LSI   | Analog |
| Analog/mixed signal         | Logic/MCU                 | Analog/mixed signal      | Memory/DRAM        | Logic  |
| Analog/other                | Logic/MPU                 | Analog/other             | Memory/DRAM & Flash | Logic  |
| Discrete/diode              | Logic/MPU & Flash         | Discrete/diode           | Memory/Flash       | MEMS   |
| Discrete/LED                | Logic/Opto                | Discrete/LED             | Memory/MRAM        | Memory  |
| Discrete/Opto               | Logic/other               | Discrete/Opto            | Memory/other       | Memory  |
| Discrete/other              | Logic/power               | Discrete/other           | Memory/SRAM        | Memory  |
| Discrete/power              | Logic/System LSI          | Discrete/power           | MEMS               |        |
| Discrete/rectifier          | Memory/DRAM               | Discrete/rectifier       |                   |        |
| Discrete/Thyristor          | Memory/DRAM & Flash       | Discrete/Thyristor       |                   |        |
| EPI                         | Memory/Flash              | Logic/DSP                |                   |        |
| Foundry/dedicated           | Memory/DRAM               | Logic/embedded           |                   |        |
| Foundry/DRAM                | Memory/other              | Logic/Flash              |                   |        |
| Foundry/IDM                 | Memory/SRAM               | Logic/MCU                |                   |        |
| Foundry/MEMS                | MEMS                      | Logic/MPU                |                   |        |
| Foundry/R&D                 | Pilot                     | Logic/MPU & Flash        |                   |        |
| Foundry/System LSI          | R&D                       | Logic/Opto               |                   |        |
| Logic/DSP                   | R&D-Pilot                 | Logic/other              |                   |        |
| Logic/Embedded              |                           | Logic/power              |                   |        |

20 De Figueiredo and Silverman (2007) builds a similar map for the laser printer industry where the resolution (measured in dots per inch, DPI) and printing speed (measured in pages per minute, PPM) form the two dimensions of their submarket map. Klepper and Thompson (2006) do the same in lasers, where they mention categorization of submarkets with regard to power and the wavelength of light that lasers emit.
The figure shows the average wafer size and geometry in each specialized “secondary” sub-market for the last year of the dataset (i.e., 2015). Highly cost-efficient fabs that focus on commodity chip production, such as memory and logic chips, are located in the high wafer size and low geometry section, whereas fabs with more particular product characteristics, such as discrete, analog, and MEMS are located in the higher geometry but lower wafer size part. Our initial insight here is that as we move to the former groups of submarkets (i.e., memory and logic) from the latter ones (i.e., discrete, MEMS, and analog), the minimum efficient scale (MES) for profitable entry increases, that is, the cost of entry increases.

Capital intensiveness and capacity levels\(^{21}\) also confirm the pattern observed in Figure 2. Following the cutting-edge technology in manufacturing, that is, moving from one wafer (or geometry) size to the other requires new machines and reconfiguration of fabs. Huge levels of capital investment are required for the equipment and construction of fabs. Memory DRAM and Flash and the logic MPU submarkets required on average $4 billion in 2015 to build a new fab. Some fabs of large incumbents in these submarkets, such as Samsung, Toshiba, or Intel currently cost more than $10 billion. Opening a new fab requires huge commitments to these submarkets. Only a handful of companies have enough capital to build a new fab for the smallest geometries and the largest wafer sizes. However, technologies that are three and four generations behind the frontier continue to be purchased and used as well (Adner & Snow, 2010), giving entrants additional chances to break into incumbent markets (Uzunca, 2018). Therefore, in technically less advanced (the larger geometry/smaller wafer) submarkets, such as discrete, analog, and MEMS, it is less expensive to build and equip a new fab.

Back when the industry was using 150 mm (6\(\text{in.}\)) wafers as the most advanced wafer size, there were over 100 companies with fabs. With the 300 mm (12\(\text{in.}\)) wafers, this number reduced to about 30 companies. In general, the number of new fabs has been slowing worldwide because with each new wafer size and process geometry, one new fab can produce many more wafers/month. This has reduced the number of fabs required to produce a given amount of capacity.

\(^{21}\)In comparing capacities, SEMI\(^{\text{TM}}\) typically uses the 8-inch (or 200 mm) equivalent monthly wafer capacity as the key metric. This normalization accounts for the different wafer sizes (thus total area being processed); therefore, for example, 10,000 wafers/month capacity looks like the following in 200 mm wafer equivalents:

- 4\(\text{in.}\) fab 10,000 wafer/month capacity = 2,500/month 200 mm equivalent
- 6\(\text{in.}\) fab 10,000 wafer/month capacity = 5,625/month 200 mm equivalent
- 8\(\text{in.}\) fab 10,000 wafer/month capacity = 10,000/month 200 mm equivalent
- 12\(\text{in.}\) fab 10,000 wafer/month capacity = 22,500/month 200 mm equivalent
chips per wafer than the previous generation. Therefore, there are practically no new entrants in the memory and logic submarkets, whereas discrete (specifically LED) and MEMS submarkets attract many entrants due to their ease of entry and future demand expectations. These entry patterns can be observed in Table 2.

In Figure 3, we compare the change in excess capacity (i.e., incumbents increasing their capacity relative to the increase in demand) in the memory submarket with the number of entrants in the memory submarket and the number of entrants in all other submarkets. Although excess capacity in the memory submarket seems to be negatively associated with own submarket entry, it matches well with entry into all other submarkets. Entry across submarkets, hence, provides interesting patterns consistent with entry diversion.

Fab entry can be greenfield, where a new entrant starts operating its fab for the first time, or related to an incumbent from a different submarket. Regardless of the entrant’s type, a firm can enter the semiconductor manufacturing submarkets in two ways: either by building a new fab or by buying existing production facilities from other firms. We summarize possible combinations of these entry methods and different entrant types in Table 3 (cf. Dunne, Roberts, & Samuelson, 1989).

First, firms can enter via constructing a new fab. For example, CanSemi is a new billion-dollar startup semiconductor company with its own 300 mm wafer fab in Guangzhou, China, that entered analog, power, and microcontroller manufacturing for the Internet of Things, car networking, artificial intelligence, and 5G products. This same method of entry could be used by incumbent firms, for example, Infineon building a new 300 mm fab in power devices in the analog submarket or SK Hynix building a new memory fab.

Second, firms can enter by buying existing production facilities from other firms. This method of entry manifests itself either in changing the intended use of a fab (i.e., changing submarkets) or in changing the ownership of the fab—for example, an entrant buying from or being acquired by an industry incumbent. As an example of the former, Sanan Integrated Circuit Co., Ltd. (Sanan IC) is a greenfield entrant that spun-off from Sanan Optoelectronics Co., Ltd. to enter the power devices (i.e., analog submarket). As an example of the latter, SkyWater Technology is a greenfield entrant that purchased the ownership of Cypress Semiconductor’s fab in Bloomington, Minnesota, for $30 million as a standalone business. Similar examples can be found for incumbent entrants as well. For example, ON Semiconductor purchased a majority stake in Fujitsu’s 8-inch wafer fab to enter GaN power production. Another incumbent entry example via changing submarkets (repositioning) is TowerJazz, a recognized analog foundry leader, acquiring Panasonic fabs to enter CMOS image sensor products (i.e., MEMS) in Japan. Finally, an incumbent entry by changing the ownership of a fab happened when Sony Semiconductor acquired, for $58 million, Renesas Electronics’ 300 mm wafer fab for image sensors, a key component used in smartphones and tablets.

Similarly, many companies entered the memory submarket over the past three decades, and most failed within one or two technology generations. These fabs were often diverted to making analog or mixed signal products, and more recently MEMS, discrete LED, and power devices. As memory and logic submarket incumbents increase their capacities rapidly and aggressively, some firms exit from these submarkets and focus their efforts on different ones. For example, Texas Instruments, the third largest semiconductor manufacturer worldwide, exited the Complementary metal–oxide–semiconductor (CMOS) development—Logic ASSP (application specific standard product)—in the mid-2000s and entered into the analog submarket. Similarly, ST Microelectronics, the largest semiconductor manufacturer in Europe, exited from memory and entered into analog and MEMS.
| Submarkets               | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|--------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Analog/linear            | 2    | 7    | 2    | 2    | 3    | 4    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 0    | 3    | 2    | 0    | 0    |
| Analog/mixed signal      | 6    | 9    | 3    | 4    | 2    | 7    | 9    | 5    | 6    | 8    | 3    | 4    | 0    | 0    | 3    | 0    | 4    | 0    | 1    | 0    | 0    |
| Analog/other             | 4    | 3    | 2    | 7    | 9    | 2    | 2    | 3    | 2    | 4    | 3    | 3    | 5    | 4    | 1    | 1    | 2    | 2    | 0    | 1    | 0    |
| Analog/power             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 4    |
| Discrete/Diode           | 3    | 6    | 3    | 2    | 2    | 4    | 1    | 6    | 2    | 0    | 1    | 1    | 10   | 7    | 1    | 1    | 5    | 2    | 1    | 1    |      |
| Discrete/Opto            | 4    | 3    | 2    | 4    | 12   | 6    | 11   | 3    | 4    | 11   | 10   | 9    | 13   | 19   | 4    | 4    | 9    | 5    | 9    | 5    |      |
| Discrete/other           | 5    | 2    | 2    | 3    | 3    | 3    | 3    | 2    | 2    | 5    | 3    | 4    | 8    | 4    | 3    | 0    | 3    | 3    | 3    | 0    |      |
| Discrete/power           | 9    | 18   | 5    | 17   | 13   | 10   | 7    | 11   | 8    | 10   | 13   | 8    | 3    | 15   | 10   | 5    | 9    | 10   | 15   | 12   |      |
| Discrete/rectifier       | 1    | 0    | 2    | 0    | 0    | 1    | 0    | 0    | 0    | 1    | 0    | 1    | 4    | 3    | 0    | 0    | 0    | 0    | 0    | 2    | 1    |
| Discrete/Thyristor       | 0    | 2    | 0    | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 1    | 0    | 1    | 0    | 0    | 1    | 0    | 1    | 0    |      |
| Discrete/other           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Logic/DSP                | 0    | 1    | 0    | 0    | 0    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 0    |      |
| Logic/Embedded           | 1    | 0    | 1    | 2    | 4    | 4    | 5    | 6    | 2    | 1    | 4    | 1    | 4    | 1    | 2    | 1    | 2    | 1    | 0    | 0    |
| Logic/Flash              | 0    | 0    | 2    | 2    | 1    | 0    | 0    | 2    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Logic/MCU                | 1    | 3    | 2    | 4    | 1    | 1    | 3    | 9    | 5    | 3    | 2    | 3    | 8    | 1    | 4    | 0    | 2    | 3    | 1    | 0    |
| Logic/MPU                | 3    | 3    | 2    | 7    | 4    | 2    | 0    | 4    | 4    | 3    | 2    | 2    | 3    | 2    | 0    | 1    | 3    | 1    | 1    | 1    |
| Logic/MPU & Flash        | 1    | 1    | 0    | 0    | 0    | 0    | 5    | 0    | 0    | 2    | 3    | 0    | 1    | 0    | 0    | 0    | 0    | 0    |      |      |
| Logic/Opto               | 0    | 0    | 0    | 0    | 1    | 5    | 3    | 3    | 1    |      |      |      |      |      |      |      |      |      |      |      |      |
| Logic/other              | 13   | 9    | 3    | 33   | 14   | 20   | 17   | 21   | 10   | 16   | 12   | 11   | 11   | 7    | 16   | 8    | 2    | 10   | 8    | 5    |
| Logic/power              | 1    | 1    | 0    | 0    | 0    | 0    | 1    | 5    | 9    | 5    | 9    | 5    | 2    | 0    | 2    | 1    | 1    | 2    | 1    | 2    |
| Logic/System LSI         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| MEMS                     | 0    | 1    | 0    | 0    | 0    | 1    | 2    | 2    | 13   | 6    | 17   | 3    | 8    | 8    | 10   | 12   | 9    | 6    | 10   | 12   |
| Memory/DRAM              | 14   | 13   | 10   | 15   | 6    | 12   | 5    | 9    | 1    | 5    | 9    | 5    | 2    | 0    | 2    | 1    | 1    | 2    | 1    | 2    |
| Submarkets           | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|----------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Memory/DRAM & Flash  | 1    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 2    | 1    | 1    | 3    | 3    | 1    | 0    |      |      |      |
| Memory/Flash         | 5    | 4    | 2    | 1    | 6    | 7    | 4    | 6    | 9    | 2    | 5    | 5    | 4    | 2    | 1    | 3    | 5    | 1    | 5    | 5    |
| Memory/MRAM          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Memory/other         | 1    | 6    | 1    | 1    | 4    | 6    | 1    | 3    | 0    | 1    | 2    | 2    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Memory/SRAM          | 2    | 3    | 0    | 5    | 3    | 5    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    |
| Total                | 74   | 93   | 44   | 108  | 87   | 97   | 72   | 94   | 68   | 84   | 91   | 64   | 102  | 153  | 120  | 90   | 94   | 88   | 90   | 74   |
The heterogeneity in entry patterns among these modes of entry can be observed in their specific submarket entry choices as well. For example, we can track the movement of fabs changing submarkets as shown in the transition matrix in Table 4. Around one third of all fabs that change submarkets come from the memory submarket and are repurposed into the logic submarket (cf. Kim & Kogut, 1996). In Figure 4, the number of newly built greenfield fabs and fabs that change submarkets are shown separately for each year. The majority of fabs that

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FIGURE 3  Memory excess capacity compared with own versus other submarket entrants

TABLE 3  Entrant type and method in semiconductor manufacturing

| Entrant typea | New plant construction | Purchasing existing plant | Changes submarket | Changes ownership |
|---------------|------------------------|---------------------------|-------------------|------------------|
| Greenfield    | New/single plant (e.g., CanSemi is a new foundry in China) | Diversifying/single plant (e.g., Sanan-IC spun out of Sanan Opto in order to enter power device market) | Buying existing fab (e.g., SkyWater technology buys Cypres fab) |
| Incumbent     | Expansion/diversification (e.g., SK Hynix to build new fab; Infineon new 300 mm fab) | Repositioning (e.g., ON Semi increased stake in Fujitsu to access to GaN power capacity; TowerJazz acquires Panasonic fabs to establish foundry base in Japan) | Acquisition (e.g., Sony buys Renesas fab) |

aGreenfield entrants are single plant firms that are younger than 8 years. Incumbent entrants are firms that either have had at least one fab for more than 8 years or has two or more fabs.
change submarkets choose logic and they come from memory, whereas the majority of newly built greenfield fabs choose to enter the discrete submarket.22

### 6 | METHODS

#### 6.1 | Measurement and empirical analysis

Our empirical strategy to test the entry diversion model comprises three steps: (1) how incumbents respond to threat of entry by building (excess) capacity (i.e., increasing their capacity

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22The LED (Discrete) submarket experienced exceptional entry rates during 2009, 2010, and 2011 due to favorable policies in Chinese market. We will address this in the empirical analysis.
more than the increase in demand), (2) how actual entry in one submarket is affected by these preemptive capacity investments (a) in the same submarket and (b) in all other submarkets, and (3) whether greenfield and incumbent entrants respond differently to entry diversion.

We operationalized incumbents versus entrants in two steps (Uzunca, 2018). First, we coded firms that own more than one fab in the industry as incumbents (Dunne et al., 1989; Dunne, Roberts, & Samuelson, 1988). The rationale behind this coding is straightforward: when a new firm enters the industry, it typically enters with a single-fab. New firm entry with multiple plants is not common in semiconductor manufacturing due to high costs of opening a new fab. Furthermore, moving from one to multiple fabs is considered a big milestone for semiconductor companies. Even TSMC, the world’s largest dedicated independent foundry, first entered the industry in 1987 with one fab. The second fab was opened 3 years later, in 1990. Second, following prior literature (Boeker, 1989; Eisenhardt & Schoonhoven, 1990; Giustiziero, Kaul, & Wu, 2018; Li & Atuahene-Gima, 2001; McCann, 1991; Uzunca, 2018), we coded single-plant firms that have been active in the industry for more than 8 years as incumbents as well. Therefore, for each firm, we coded Incumbent = 1 if either the firm has had at least one fab for more than 8 years or has two or more fabs. In this way, we assured that incumbency is related to both firm size and age (Hannan & Freeman, 1984; Sutton, 1997). This coding allowed us to categorize firms as industry incumbents or not, regardless of what their fabs produced. Entrant firms account for 23.14% of the total number of firms in each year but only 5.32% of the output of production. Incumbents, on average, own 3.07 plants. Table 5 shows the number of new plants constructed by entrants versus incumbents. We see entry happening in all submarkets; thus, we can argue that, over the long run, entry was never completely deterred or blockaded, even at the submarket level. Furthermore, the table indicates that when new plants were built, they were 4.4 times more likely to be constructed by incumbents than by new entrants.

In a first preliminary analysis to test the validity of our excess capacity assumption, we estimated a regression model to examine if excess capacity responds to threat of entry in the same submarket. For the “threat of entry” construction, we exploit a unique measure of the probability of entry in our dataset. It denotes the degree of credibility of threat by entrants as evaluated by experts in the semiconductor industry and is measured in the WFW dataset by the “Future fabs”—that is, planned/announced fabs that have probability below 1. Excess capacity growth (more wafer capacity installed per chip sold) is significantly associated with announcements of entry. Results are not reported as they replicate earlier findings in the literature, but are available upon request.

24 The results are robust to the use of alternative specifications, such as 3, 5, and 11 years.

25 If an entrant is acquired by an industry incumbent—the entrant sells its fab and exits the industry—the entrant’s fab is recoded thereafter as an incumbent. Likewise, if entrants enter by buying production facilities from an incumbent—instead of building new plants—the fab is recoded thereafter as an entrant (see Uzunca, 2018).

| Submarket | Average number of firms | Average number of plants | Entrants | Incumbents |
|-----------|-------------------------|--------------------------|----------|-----------|
| Analog    | 49                      | 110                      | 26       | 115       |
| Discrete  | 152                     | 311                      | 163      | 483       |
| Logic     | 61                      | 220                      | 26       | 318       |
| MEMS      | 23                      | 35                       | 29       | 56        |
| Memory    | 26                      | 115                      | 27       | 232       |

Table 5: Number of new plants constructed by entrants versus incumbents.
6.1.1 Incumbents’ excess capacity

We argue that the existence of excess capacity as entry deterrence at the submarket level will be reflected by the gap between submarket capacity and submarket demand. As capacity outstrips demand, this increases the difficulty of entering the submarket. Excess capacity makes entry difficult by raising expectations of potential entrants that industry incumbents can respond aggressively to competition following their entry (Eaton & Lipsey, 1980). In other words, with excess capacity, industry incumbents can threaten entrants to expand output and cut prices post-entry, thereby making entry unprofitable (Lieberman, 1987b). \( \text{ExcessCapacity}_{jt} \) denotes incumbents’ capacity investments that are above the demand in submarket \( j \) in year \( t \).\(^{26} \) Incumbents may construct excess capacity for both strategic and non-strategic reasons (Lieberman, 1987a, 1987b). In industries where demand growth rates are high, incumbents engage in non-strategic capacity expansions. Strategic capacity investments, the primary hypothesis we examine here, requires incumbents to invest preemptively in their capacity more than the expected demand increase (Cookson, 2018).\(^{27} \) Thus, we capture entry deterrence through calculating a ratio of supply to demand (responsiveness of the capacity investments to changes in demand)\(^{28} \):

\[
\text{ExcessCapacity}_{jt} = \frac{\text{Capacity}_{jt}}{\text{Demand}_{jt}}
\]

where \( \text{Capacity}_{jt} \) denotes the total stock of capacity investment in 8-inch equivalent monthly wafers by incumbents in submarket \( j \) in year \( t \) (in billions), and \( \text{Demand}_{jt} \) denotes the semiconductor sales per submarket-year in millions of dollars. Here, increasing excess capacity means capacity is increasing more than proportionately compared to demand. For smoothing any yearly fluctuations, we calculate entry deterrence using 3-year moving averages (cf. Lieberman, 1987b)\(^{29} \):

\[
\text{ExcessCapacity}_{jt} = \frac{\left( \frac{\text{Capacity}_{j,t-3} + \text{Capacity}_{j,t-2} + \text{Capacity}_{j,t-1}}{3} \right)}{\left( \frac{\text{Demand}_{j,t-3} + \text{Demand}_{j,t-2} + \text{Demand}_{j,t-1}}{3} \right)}
\]

[Correction added on 31 January 2020, after first online publication: in the second equation under subsection 6.1.1, the first ‘Capacity’ in numerator has been corrected to ‘Capacity\(_{j,t-3}\)’.

6.1.2 Entry diversion

For testing our main prediction from entry diversion, we estimate the following model:

\[
\text{TotalEntrant}_{jt} = \beta_1 \text{ExcessCapacity}_{jt} + \beta_2 \text{OtherSubExcessCapacity}_{jt} + \alpha X_{jt} + \gamma_j + \delta_t + \epsilon_{jt}
\]

\(^{26}\)This construct aims to capture the gap between submarket capacity and submarket demand. If capacity per demand installed by incumbents is increasing over time, it denotes that the gap between capacity and demand is widening, giving us a good proxy for the excess capacity investments of incumbents for entry deterrence.

\(^{27}\)Demand growth can fill new capacity investments and thus reduce the strength of excess capacity for entry deterrence.

\(^{28}\)This approach—that is, capacity to demand ratio as a proxy for the incumbents’ entry deterrence—has been used before for hotels in the Texas lodging industry (Conlin & Kadiyali, 2006).

\(^{29}\)New capacity takes on average 3 years to show up in the capacity data, that’s why—and similar to Lieberman’s motivation for taking a 2-year moving average in the chemical industry—we use 3-year moving average in the semiconductor manufacturing industry.
where $\text{Totalentrant}_j$ is the total number of entrants—that is, sum of newly built fabs, diversifying fabs (i.e., existing fabs that change submarkets), and acquired/sold fabs (i.e., existing fabs that change ownership) in submarket $j$ in year $t$. As explained above, $\text{Excesscapacity}_j$ is own submarket entry deterrence. Thus, we expect $\beta_1$ to be negative. Our key independent variable, $\text{OtherSubExcesscapacity}_j$, covers the excess capacity (weighed by the cost of entry or Minimum Efficient Scale [MES]) in all the remaining submarkets ($j \neq j$) in year $t$:

$$\text{OtherSubExcesscapacity}_j = \sum_{j=1, j \neq j}^J \frac{\text{MES}_j}{\text{MES}_j} \text{Excess capacity}_j$$

This way, we distinguish our analysis from the conventional entry deterrence and examine entry diversion by considering not only the effect of the incumbents’ preemptive capacity investments in entry deterrence within the same submarket but also the effect of these investments in all other submarkets. In the case of entry diversion, we expect $\beta_2$ to be positive. In line with our predictions, we would expect the results to become stronger as diversion occurs from high MES submarkets toward lower MES submarkets as the cost of entry diversion is lower in submarkets with higher MES. Thus, while calculating the excess capacity investments in all the remaining submarkets, we also weighted each submarket’s excess capacity by multiplying with their MES ($j$) and by dividing the MES of the focal submarket ($j$). This way we incorporate two crucial elements of our theoretical model: directionality of diversion and relative differences in entry deterrence across submarkets.

$X_{jt}$ includes a measure of competitive intensity in the submarket, submarket density (lagged), and, a submarket trend to control for time varying submarket effects that might affect entry. All variables are defined in Table 6. We included submarket ($\gamma_j$) and year ($\delta_t$) fixed effects to account for any unobserved permanent heterogeneity that might bias our results. As the dependent variable is a “count;” we estimated a fixed-effect Poisson model with robust standard errors (the `xtpoisson` command in STATA) as it has weaker distributional assumptions compared to regular Poisson or Negative Binomial models (Cameron and Trivedi, 2009). For testing our final prediction, we separately estimated this model for greenfield and incumbent entrants.

7 | EMPIRICAL RESULTS

Table 7 reports the means, standard deviations, and correlations for the variables. Given the very high correlation between entry and submarket density (lagged), we estimate our empirical model with and without this variable.

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30We calculated MES as the average size of the largest plants accounting for the 50% of output per year (Comanor & Wilson, 1967: 438).

31In unreported robustness checks we show that weighting other submarkets’ excess capacity with the MES ratio adds meaningful explanatory power to our empirical model when we entered it together with the MES ratio and the unweighted other submarkets’ excess capacity.

32We also experimented with submarket growth; however, this variable did not add any significant explanatory power; therefore, we present the results with submarket density only.

33In the Appendix, we provide negative binomial and OLS regression results which are mostly consistent with our Poisson model (See appendix Table A1, A2, A3, A4).
### TABLE 6  Definition of variables and summary of predictions

| Variable                  | Definition                                                                 | Prediction<sup>a</sup> |
|---------------------------|---------------------------------------------------------------------------|-------------------------|
| **Submarket-level variables** |                                                                          |                         |
| Capacity<sub>jt</sub>    | Incumbents' \( (Incumbent_{lt} = 1) \) capacity investments (in billions) in submarket \( j \) at time \( t \) | Negative                |
| Demand<sub>jt</sub>      | Total sales (in millions) in submarket \( j \) at time \( t \)           |                         |
| ExcessCapacity<sub>jt</sub> | Capacity<sub>jt</sub> / Demand<sub>jt</sub> (3 yr moving average)           | Negative                |
| OtherSubExcessCapacity<sub>jt</sub> | Weighted average of ExcessCapacity<sub>kt</sub> in all submarkets \( k \) except \( j \) at time \( t \), weighted with MES (3 yr moving average) | Positive               |
| TotalEntrants<sub>jt</sub> | Total number of entrants (new + diversifying + acquired/sold fabs) in submarket \( j \) at time \( t \) |                         |
| GreenfieldEntrants<sub>jt</sub> | Total number of greenfield entrants' \( (Incumbent_{lt} = 0) \) fabs in submarket \( j \) at time \( t \) |                         |
| IncumbentEntrants<sub>jt</sub> | Total number of incumbent entrants' \( (Incumbent_{lt} = 1) \) fabs in submarket \( j \) at time \( t \) |                         |
| SubmarketDensity<sub>t</sub> | Number of firms (in hundreds) in submarket \( j \) at time \( t \) (lagged) |                         |
| **Firm-level variables** |                                                                          |                         |
| Incumbent<sub>lt</sub>   | One if firm \( l \) has more than one fab at time \( t \), or, if firm \( l \) has one fab and is older than 8 years at time \( t \); zero otherwise. |                         |
| Submarketincumbent<sub>lt</sub> | One if firm \( l \) is an industry incumbent \( (Incumbent_{lt} = 1) \) and did not change submarkets, and zero otherwise. |                         |
| **Fixed effects** |                                                                          |                         |
| Submarket<sub>j</sub>, Year<sub>t</sub> | Submarket and year-level fixed effects                                      |                         |

<sup>a</sup>All predicted effects are on TotalEntrants<sub>jt</sub>.

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### TABLE 7  Descriptive statistics and intercorrelations

| Variable                   | Mean  | SD    | Min. | Max. | 1     | 2     | 3     | 4     | 5     | 6     | 7     |
|----------------------------|-------|-------|------|------|-------|-------|-------|-------|-------|-------|-------|
| (1) Capacity               | 2.20  | 2.08  | 0.0025 | 7.4583 | 0.046 | 0.148 | 0.124 | 0.158 |
| (2) Demand                 | 0.04  | 0.04  | 0.0042 | 0.1558 | 0.778 |
| (3) ExcessCapacity         | 0.05  | 0.31  | 0.0006 | 0.1347 | 0.651 | 0.135 |
| (4) OtherSubExcessCapacity | 0.17  | 0.17  | 0      | 0.721  | -0.373 | -0.273 | -0.300 |
| (5) TotalEntrants          | 17.87 | 15.42 | 0      | 112    | 0.046 | 0.148 | 0.124 | 0.158 |
| (6) GreenfieldEntrants     | 2.56  | 3.94  | 0      | 29     | -0.135 | -0.143 | 0.086 | 0.280 | 0.861 |
| (7) IncumbentEntrants      | 15.31 | 12.25 | 0      | 83     | 0.103 | 0.236 | 0.129 | 0.107 | 0.986 | 0.762 |
| (8) SubmarketDensity       | 0.621 | 0.549 | 0.01  | 2.48   | -0.038 | 0.0001 | 0.177 | 0.389 | 0.747 | 0.718 | 0.711 |
In Table 8, we estimate entry into a submarket and first introduce our two main independent variables; ExcessCapacity and OtherSubExcessCapacity, without year or submarkets effects. We include the submarket and year fixed effects sequentially (model (3) and (4)), and we run the full model with submarket density and submarket and year fixed effects. As expected, in the full model, both the sign and the significance of the own submarket excess capacity are in line with our expectation ($b = -14.30, p < 0.01$); an increase in investments in entry deterrence in one submarket seems to decrease the number of entrants into that submarket: an increase in excess capacity by one million (more 8-inch equivalent monthly wafer capacity installed per chip sold), decreases the total number of entrants by 2% ($\exp[-0.01430] = 0.98$ or 98% of the base rate). This is the conventional effect of “entry deterrence,” but estimated at the submarket level. However, the effect of other submarkets’ excess capacity is positive and highly significant ($b = 3.33, p < 0.01$). This means that investments in entry deterrence by incumbents in other submarkets seem to significantly increase the number of entrants into the focal submarket (entry diversion). An increase in excess capacity in other submarkets by ten million, increases the total number of entrants by 3% ($\exp[0.0333] = 1.03$ or 103% of the base rate).

Thus, there is statistically significant and economically relevant evidence that is consistent with entrants being diverted to a focal submarket when incumbents in other submarkets increase their investments in excess capacity. Incumbents’ capacity investments in their own submarket decrease the number of entrants into the focal submarket, whereas corresponding investments in other submarkets with relatively higher costs of entry (or lower costs of entry diversion) increase entry into the focal market, even when controlling for submarket density, and, submarket and year fixed effects. In model (5), we also add a set of submarket-specific time trends in an attempt to rule out potential spurious correlation if time trends differ among the submarkets. This is a rather blunt test for ruling out alternative explanations as entry diversion might affect the trend itself through the entry behavior of firms. Moreover, Table 2 and Figure 4 do not seem to indicate a linear trend in entry within different submarkets. When adding a submarket time trend, we do fail to find robust results for our OtherSubExcessCapacity measure and the coefficient of ExcessCapacity increases dramatically. However, we run these models with only 100 observations (20 observations per submarket) and including five separate submarket time trends (together with the submarket fixed effect) which makes us lose further degrees of freedom.

One potential concern is the wave of entry in the discrete submarket occurring in 2009–2011 which is attributable to important incentives in China for new LED fab investments. We tackle this problem in two ways: (1) in models (6–7), we dropped the observations of the years 2009–2011 from our sample, and (2) in models (8–9), we dropped the discrete submarket completely from our analyses. Note that our entry diversion mechanism plays across submarkets and that dropping a submarket implies assuming this submarket does not affect entry and diversion incentives in other submarkets. For this reason, we prefer dropping all observations for 2009, 2010, and 2011 and maintaining all five submarkets in the analysis. The results in Table 8 models (6) through (9) all show largely robust results. Nevertheless, when dropping the

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34The average incumbent investment in capacity per year in a submarket is 2.5 million wafers-per-month (wpm). With linear extrapolation, and taking demand constant, this effect implies that, the average capacity investment by incumbents decreases the total number of entrants by 5%.

35Following a similar logic as in the previous footnote and additionally assuming relatively similar MES across submarkets (due to weighing we apply in this measure), this effect implies that, the average capacity investment by incumbents in other submarkets increases total number of entrants by 3%.

36In particular, this requires us to recalculate our OtherSubExcessCapacity variable for four submarkets only.
Discrete submarket and including submarket density (model (9)), the coefficient of OtherSubExcessCapacity is lower and loses some significance \((p = 0.069)\). Interestingly, the coefficient of ExcessCapacity drops significantly when dropping the years with the outliers in entry (models (6) and (7)). Entry into LED increases capacity investments into the Discrete submarket, representing a huge increase of capacity relative to demand. Dropping the years with outlier entry into the Discrete submarket does not seem to affect the effect of OtherSubExcessCapacity on entry. Therefore, we do not believe that the outliers in the LED submarket are driving our main result. Taken together, our results do seem to support the entry diversion mechanism, although we cannot fully eliminate potential spurious correlation due to time varying submarket specific effects.

### TABLE 8  Conditional fixed-effects Poisson regressions for entry diversion between submarkets (total entrants)

| Variables              | Base model | Drop 2009–2011 | Drop discrete |
|------------------------|------------|----------------|---------------|
|                        | (1)        | (2)            | (3)           | (4)           | (5)           | (6)           | (7)           | (8)           | (9)           |
| ExcessCapacity         | −11.69     | −13.67         | −14.31        | −14.30        | −22.88        | −7.16         | −7.17         | −10.08        | −11.48        |
|                        | (1.729)    | (4.665)        | (4.226)       | (3.948)       | (7.109)       | (4.126)       | (3.974)       | (3.003)       | (3.581)       |
| OtherSubExcessCapacity | 1.98       | 2.88           | 2.88          | 3.33          | −0.65         | 2.91          | 3.21          | 3.76          | 1.25          |
|                        | (0.318)    | (0.213)        | (0.241)       | (0.269)       | (1.604)       | (0.293)       | (0.436)       | (0.150)       | (0.689)       |
| SubmarketDensity       | −0.15      | 0.20           | −0.09         | 2.62          |               |               |               |               |               |
|                        | (0.114)    | (0.431)        | (0.126)       | (0.602)       |               |               |               |               |               |
| tSubmarket1            | 0.02       |                |               |               |               |               |               |               |               |
|                        | (0.019)    |                |               |               |               |               |               |               |               |
| tSubmarket2            | 0.07       |                |               |               |               |               |               |               |               |
|                        | (0.017)    |                |               |               |               |               |               |               |               |
| tSubmarket3            | 0.01       |                |               |               |               |               |               |               |               |
|                        | (0.015)    |                |               |               |               |               |               |               |               |
| tSubmarket4            | 0.22       |                |               |               |               |               |               |               |               |
|                        | (0.056)    |                |               |               |               |               |               |               |               |
| tSubmarket5            | 0.02       |                |               |               |               |               |               |               |               |
|                        | (0.031)    |                |               |               |               |               |               |               |               |
| Constant               | 3.22       | 2.97           |               |               |               |               |               |               |               |
|                        | (0.245)    | (0.260)        |               |               |               |               |               |               |               |
| Observations           | 100        | 100            | 100           | 100           | 85            | 85            | 80            | 80            | 80            |
| Number of submarket    | 5          | 5              | 5             | 5             | 5             | 5             | 4             | 4             | 4             |
| Submarket FE           | No         | No             | Yes           | Yes           | Yes           | Yes           | Yes           | Yes           | Yes           |
| Year FE                | No         | Yes            | Yes           | Yes           | Yes           | Yes           | Yes           | Yes           | Yes           |
| Log likelihood         | −407.05    | −344.45        | −309.21       | −308.75       | −283.13       | −240.01       | −239.92       | −221.64       | −212.70       |
| Degrees of freedom     | 97         | 78             | 78            | 77            | 73            | 66            | 65            | 58            | 57            |

Notes: Robust standard errors in parentheses.
To test our final prediction, we separate our dependent variable into greenfield entrants and incumbent entrants. The results of these regressions are presented in Table 9. As we predict, the effects for both ExcessCapacity and OtherSubExcessCapacity are generally stronger for greenfield entrants as compared to incumbent entrants across most of the models (except across model (2) and (6)). On average, the same level of investment in own submarket excess capacity deters 1.5 times more greenfield entrants than incumbent entrants. Similarly, other submarket excess capacity diverts on average two times more greenfield entrants into a focal submarket compared with incumbent entrants. Unfortunately, we cannot conclude that these point estimates are also statistically different given the estimated standard errors. Nevertheless, this finding is suggestive that greenfield entrants are more responsive to entry diversion than incumbent entrants. One reason for this difference is that incumbent entrants have already developed production facilities and capabilities which make their entry decisions more difficult to change compared to a decision of entering as a greenfield firm. Because incumbents' previous investments have some sunk value, their options to change submarkets are more limited (Cabral, 2012; Dixit & Shapiro, 1986; Tirole, 1988). This finding explains why diversion of incumbents would be more difficult than greenfield entrants. It takes years for a memory or logic company to become a MEMS company as the technologies required for producing those chips are completely different from each other (Uzunca, 2018). Greenfield entrants are free from those constraints; therefore, their decisions to enter into a specific submarket are more flexible (Leonard-Barton, 1992; Tushman & Anderson, 1986). Moreover, similar to Lieberman’s (1987a) “mobility-deterring” argument, these findings are also consistent with strategic behavior by incumbents that accommodate greenfield entrants to a lesser extent than they accommodate each other in their own submarket.

7.1.1 | Additional robustness check

Our mechanism of entry diversion argues that entry deterrence in other submarkets affects entry into the focal submarket. Although entry diversion seems to affect greenfield entry more than incumbent entry into the focal submarket, it should not really affect expansion decisions by incumbents already active in the focal submarket. As an additional robustness check, we test this corollary for our model. At the same time, this analysis checks that our findings are not based on spurious correlation between our main independent variable OtherSubExcessCapacity and entry into the focal submarket as it might pick up demand related unobserved heterogeneity affecting all submarkets in the industry.

37 Dropping the Discrete submarket has little effect on the results for greenfield entry, suggesting that these greenfield entrants are diverted to different submarkets depending on the excess capacity investments in other submarkets. Incumbent entrants are more constrained to which submarkets they can get diverted and the results for these incumbent entrants are affected by dropping the Discrete submarket as the coefficient of OtherSubExcessCapacity becomes insignificant.

38 One more reason for the difference in diversion of greenfield versus incumbent entrants is that greenfield entrants are also less knowledgeable than diversifying entrants about future prospects of markets (such as demand forecast and investments on entry deterrence), thus they have a higher likelihood to first queue to submarkets with high profitability (and high investments on entry deterrence) and then realize during the process that entry is not viable, and abandon their plans (Table 5) or divert their attention and enter into submarkets with lower investments on entry deterrence.

39 We would like to thank the editor for suggesting this additional test.
| Variables            | Greenfield entrants | Incumbent entrants | Submarket incumbents |
|----------------------|---------------------|---------------------|----------------------|
|                      | (1) (2) (3) (4)     | (5) (6) (7) (8)     | (9) (10)             |
| ExcessCapacity       | −22.88 −19.08 −3.46 | −20.39 −19.08 −3.46 | −20.39 −19.08 −3.46 |
| (6.995) (8.016)       | (10.095) (6.759)    | (10.095) (6.759)    | (10.095) (6.759)     |
| OtherSubExcessCapacity| 4.84 3.44 4.87 4.38 | 2.73 3.64 3.38 1.18 | 2.15 0.55           |
| (1.827) (0.825)       | (1.497) (2.135)     | (0.418) (0.298)     | (0.952) (2.708)      |
| SubmarketDensity      | 0.70 0.60 1.49      | −0.28 −0.21 2.98    | 0.43                 |
| (0.383) (0.414)       | (1.310) (0.763)     | (0.831)             |
| Observations          | 100 100 85 80       | 100 100 85 80       | 100 100              |
| Number of submarket   | 5 5 5 4             | 5 5 5 4             | 5 5                  |
| Submarket FE          | Yes Yes Yes Yes     | Yes Yes Yes Yes     | Yes Yes              |
| Year FE               | Yes Yes Yes Yes     | Yes Yes Yes Yes     | Yes Yes              |
| Log likelihood        | −150.20 −148.62 −118.27 −93.01 | −284.82 −283.48 −227.16 −201.01 | −117.76 −117.54 |
| Degrees of freedom remaining | 78 77 65 57         | 78 77 65 57         | 78 77                |
|                       |                     |                     |                     |

Notes: Robust standard errors in parentheses.
To demonstrate this asymmetric behavior between entrants into the submarket and incumbents already active in the submarket, we need some additional terminology. We name a firm a submarket incumbent if the firm is an industry incumbent (i.e., our original Incumbent measure), and it does not change submarkets. Then, we calculated new fabs built by these submarket incumbents (regardless of in which submarket they are). To see which of these fabs are opened in the same submarket as the submarket incumbent, we manually went through all of our observations and coded them accordingly. All the remaining new fabs that are opened by submarket incumbents in other submarkets are part of what we call diverted incumbent entrants.

We report the results of this regression in the final two columns of Table 9 (models 9 and 10). Although the sign of the coefficient of OtherSubExcessCapacity is positive, it loses significance in the full model when controlling for submarket density. Submarket incumbents that open new fabs in their own submarket do not seem to be affected by entry diversion. Therefore, we conclude that “OtherSubExcessCapacity” is not picking up some kind of unobserved heterogeneity or signal of submarket growth.

8 | DISCUSSION AND CONCLUSION

In this article, we contribute to the entry literature by advancing a new and potentially important mechanism within the broad topic area of entry deterrence. We call this new mechanism entry diversion. The traditional entry deterrence literature argues that entry deterrence efforts aim to decrease entrants’ profits to below zero to deter their entry into the industry. Our mechanism of entry diversion argues that it is sufficient to deter entry into a different submarket of the same industry. Rather than being deterred from the industry entirely our findings suggest that entry deterrence is effective at the submarket level. Therefore, entry diversion provides an alternative explanation for the limited empirical evidence for classical models of entry deterrence at the industry level.

Using a novel submarket level panel dataset in the global semiconductor manufacturing industry, we argue that incumbents respond preemptively to a threat of entry by expanding their capacity in their submarket and that these investments (particularly in memory and logic submarkets) divert both greenfield and incumbent entrants towards other submarkets. Capacity additions are a natural response to demand growth. But the continuous push for technology by incumbents can also be driven by a strategic response to competitive pressures which forces semiconductor manufacturers to scale production aggressively in order to maintain their competitive position (cf. Lieberman, 1987a, 1987b). Companies that cannot withstand this pressure fail or divert to different submarkets. New submarkets are opened by diverted entrants; their product innovation is not only driven by demand growth, but also by the fact that there is no room left for profitable entry in other submarkets (Uzunca, 2018).

Entry diversion is not only about redefining industry boundaries at the submarket level where entry deterrence seems to happen. More importantly, entry diversion proposes that the industry dynamics at the submarket level affect overall industry dynamics (cf. Ethiraj & Zhou, 2019). Strategic investments by incumbents in a particular submarket affect entry into other submarkets. First, greenfield entry into the industry is directed away from the focal submarket toward other submarkets in the industry. Second, these investments also direct some incumbents active in the focal submarket out of the submarket and into other submarkets. As a result, entry diversion relates the behavior of different types of entrants into a particular submarket to submarket dynamics driven by strategic considerations of incumbents in other submarkets.
Our empirical context of the semiconductor industry highlights the role of entry diversion through capacity expansions by incumbent firms in their submarkets. The logic of the entry diversion mechanism directly extends to different forms of entry deterrence that have been examined in the literature, such as investments in advertising or R&D, limit pricing effects, or, raising rivals’ costs. For generalizing the mechanism of entry diversion to other settings, it is important to be able to identify viable submarkets within the industry or environment. For example, Lerner (1995) finds that biotech startups with high litigation costs tend to avoid patenting in crowded subclasses especially when those subclasses are inhabited by incumbents with low litigation costs. This seems to have direct parallels to diversion toward other submarkets within an industry.

Entry diversion differs from existing but related concepts, such as mobility barriers (Caves & Porter, 1977) or the effect of resource partitioning (Carroll, 1985). Although mobility barriers between strategic groups also seem to divert—high barriers to entry and the high rates of entry correspond to different groups or segments within the industry—the framing is different from entry diversion. Incumbents in strategic groups and submarkets respond differently to potential rivalry. Strategic groups delineate intensity of rivalry with regard to their origin: if rivalry originates from the firms’ own group, then the retaliatory response will be less severe than if it originates from other groups (Peteraf, 1993). Submarkets delineate intensity of rivalry with regard to their target: if rivalry targets firms’ own submarket, then the retaliatory response will be more severe than if it targets other submarkets. Furthermore, strategic groups mainly reflect the socio-cognitive structure and perceptions of managers about their interactions with firms with similar strategies—thus, they depend on the managerial representations of the industry landscape (Cattani, Porac, & Thomas, 2017). Group members use this cognitive identity in their favor by raising mobility barriers as a result of their collective action, that is, explicit within strategic group coordination is needed among firms that decreases rivalry, such as oligopolistic coordination (Peteraf, 1993). Submarkets reflect the supply and demand conditions of the products that are substitutable according to buyers, thus their existence is not directly related to managers’ perceptions or the socio-cognitive structure of the industry landscape.

In resource partitioning, a generalist incumbents’ dominance in one segment affects the emergence of a new organizational form, a specialist, in other niches of the industry (Carroll, 1985). Notwithstanding this similarity, entry diversion posits a very different and broader approach than resource partitioning for entry deterrence at the submarket level as diverted entrants, and incumbents might have similar organizational forms and do not necessarily depend on a particular distribution of resources or stay in “isolated” resource islands. Most importantly, incumbents strategically divert entrants to other submarkets, whereas resource partitioning does not contemplate any strategic behavior on the part of the incumbents.

Our study is not without limitations. First of all, although we control for alternative explanations, we cannot fully assure that firms invest strategically in excess capacity. Some authors have argued that controlling for demand is enough for assuring that incumbent capacity expansions are strategic to deter entry because otherwise entry and incumbent investments will be positively related (Cookson, 2018). However, in our view, claiming incumbents’ preemptive investments as strategic just because entry is less likely when these capacity expansions increase is not enough. Our results are therefore consistent with strategic capacity investments by incumbents (Lieberman, 1987a), but empirically separating the strategic “overinvestment” by incumbents is an important remaining empirical challenge.

Finally, with our model of entry diversion, we argue that entrants change their plans and are diverted toward alternative submarkets because of the preemptive strategic investments by
incumbents in particular submarkets. Due to the nature of our data, we cannot show that entrants actually do get diverted. We provide more qualitative evidence that entrants and incumbents get diverted; however, for greenfield entrants, this is hard to quantify. Our evidence is consistent with entry diversion and the qualitative evidence points into that direction, but future research will need to track the dynamics of entrants’ plans before actually committing to a submarket. In the end, as we aggregate our data at the submarket level, we are left with few observations and controlling for unobserved time varying heterogeneity is a challenge. Hence, it is difficult to be conclusive on the mechanism of entry diversion. Nevertheless, we do get results consistent with the mechanism of entry diversion while including submarket and year fixed effects. Furthermore, in line with the two crucial elements of our theoretical model, namely the directionality of diversion and the relative differences in the costs of entry deterrence across submarkets, we show that entry diversion occurs from high MES submarkets towards lower MES submarkets. We look forward to future research exploring the interaction between strategic decisions of the firm and the dynamics of submarkets.

ACKNOWLEDGEMENT
We thank our Special Issue Editor Marvin Lieberman, and two anonymous reviewers for providing highly constructive feedback that allowed us to improve the manuscript substantially. We would like to also thank Dan Tracy, previous Senior Director of Industry Research and Statistics at Semiconductor Equipment and Materials International (SEMI™) for providing access to the World Fab Watch (WFW) dataset and his continued support throughout our research. Comments and insights from Andrew King, Robert Seamans, Giovanni Valentini, and Douglas Hannah helped to bring this research to fruition. Earlier versions of this paper have been presented at the 2018 AOM Annual Meetings in Chicago, Illinois, the 2013 DRUID conference in Barcelona, Spain, the 2013 EGOS Conference in Montréal, Canada and the 2012 SMS conference in Prague, Czech Republic. Bruno Cassiman acknowledges support from FWO grant G071417N from the Flemish government and MCIU grant PGC2018-094418-B-I00 from the Spanish government.

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**How to cite this article:** Uzunca B, Cassiman B. Entry diversion: Deterrence by diverting submarket entry. *Strat. Mgmt. J.* 2020;1–37. [https://doi.org/10.1002/smj.3128](https://doi.org/10.1002/smj.3128)
**APPENDIX: APPENDICES**

**TABLE A1** Negative binomial regressions for entry diversion between submarkets (total entrants)

| Variables          | Base model (1) | Base model (2) | Base model (3) | Base model (4) | Base model (5) | Drop 2009–2011 (6) | Drop 2009–2011 (7) | Drop discrete (8) | Drop discrete (9) |
|--------------------|----------------|----------------|----------------|----------------|----------------|---------------------|---------------------|-------------------|-------------------|
| ExcessCapacity     | −5.03          | −6.85          | −8.06          | −8.12          | −24.65         | −5.76               | −5.90               | −8.46             | −6.98             |
|                    | (2.885)        | (3.922)        | (3.892)        | (3.914)        | (5.655)        | (3.750)             | (3.803)             | (3.840)           | (4.387)           |
| OtherSubExcessCapacity | 1.73          | 2.79          | 2.84          | 2.91          | −1.26          | 2.95                | 3.07                | 3.72              | −0.88             |
|                    | (0.339)        | (0.482)        | (0.482)        | (0.729)        | (0.966)        | (0.442)             | (0.870)             | (0.563)           | (1.341)           |
| SubmarketDensity   | −0.03          | 0.37          | −0.04          | 4.48          |                |                     |                     |                   |                   |
|                    | (0.210)        | (0.351)        | (0.227)        | (1.098)        |                |                     |                     |                   |                   |
| tSubmarket1        | 0.03           |               |               |               |               |                     |                     |                   |                   |
|                    | (0.021)        |               |               |               |               |                     |                     |                   |                   |
| tSubmarket2        | 0.07           |               |               |               |               |                     |                     |                   |                   |
|                    | (0.032)        |               |               |               |               |                     |                     |                   |                   |
| tSubmarket3        | 0.02           |               |               |               |               |                     |                     |                   |                   |
|                    | (0.018)        |               |               |               |               |                     |                     |                   |                   |
| tSubmarket4        | 0.24           |               |               |               |               |                     |                     |                   |                   |
|                    | (0.043)        |               |               |               |               |                     |                     |                   |                   |
| tSubmarket5        | 0.03           |               |               |               |               |                     |                     |                   |                   |
|                    | (0.033)        |               |               |               |               |                     |                     |                   |                   |
| Constant           | 1.91           | 2.60          | 2.65          | 2.68          | 3.70           | 4.41                | 4.51                | 3.95              | 1.67              |
|                    | (0.324)        | (0.459)       | (0.454)       | (0.486)       | (0.473)        | (1.471)             | (1.712)             | (1.179)           | (0.639)           |
| Observations       | 100            | 100           | 100           | 100           | 85             | 85                  | 85                  | 80                | 80                |
| Number of submarket| 5              | 5             | 5             | 5             | 5              | 5                   | 4                   | 4                 | 4                 |
| Submarket FE       | No             | No            | Yes           | Yes           | Yes            | Yes                 | Yes                 | Yes               | Yes               |
| Year FE            | No             | Yes           | Yes           | Yes           | Yes            | Yes                 | Yes                 | Yes               | Yes               |
| Log likelihood     | −346.13        | −333.17       | −297.99       | −297.98       | −277.30        | −239.68             | −239.67             | −221.05           | −210.23           |
| Degrees of freedom | 97             | 78            | 78            | 77            | 73             | 66                  | 65                  | 58                | 57                |

*Notes: Standard errors in parentheses.*
## Table A2
Negative binomial Poisson regressions for entry diversion between submarkets (greenfield & incumbent entrants, submarket incumbents)

| Variables          | Greenfield entrants | Incumbent entrants | Submarket incumbents |
|--------------------|---------------------|---------------------|----------------------|
|                    | Drop 2009–2011      | Drop discrete       | Drop 2009–2011       | Drop discrete       |
| ExcessCapacity     | −22.82 (8.540)      | −16.52 (10.648)     | −22.48 (10.664)      | −8.86 (3.868)       | −7.07 (3.808)       | 4.05 (8.190)         | 2.19 (8.612)         |
| OtherSubExcessCapacity | 5.03 (1.215)    | 3.36 (1.610)        | 4.88 (2.070)         | 4.67 (2.380)        | 2.83 (0.476)        | 3.40 (0.749)         | 3.33 (0.933)         | −0.27 (1.565)        | 2.15 (1.214)        | 0.55 (2.729)         |
| SubmarketDensity   | 0.91 (0.558)        | 0.63 (0.554)        | 1.73 (1.662)         | −0.20 (0.204)       | −0.19 (0.239)       | 4.25 (1.323)         | 0.43 (0.663)         |
| Observations       | 100                 | 100                 | 85                   | 80                   | 100                 | 85                   | 80                   | 100                 | 100                 |
| Number of submarket | 5                  | 5                   | 5                    | 4                    | 5                   | 5                    | 4                    | 5                   | 5                   |
| Submarket FE       | Yes                 | Yes                 | Yes                  | Yes                  | Yes                 | Yes                  | Yes                  | Yes                 | Yes                 |
| Year FE            | Yes                 | Yes                 | Yes                  | Yes                  | Yes                 | Yes                  | Yes                  | Yes                 | Yes                 |
| Log likelihood     | −149.95 (−280.19)   | −148.06 (−279.71)   | −118.26 (−227.12)    | −92.63 (−199.77)     | −280.19 (−117.76)   | −279.71 (−117.54)    |
| Degrees of freedom remaining | 78                 | 77                  | 65                   | 57                   | 78                  | 77                   | 65                   | 57                  | 78                  | 77                  |
| Variables               | Base model | (1)  | (2)  | (3)  | (4)  | (5)  | (6)  | (7)  | (8)  | (9)  |
|------------------------|------------|------|------|------|------|------|------|------|------|------|
| ExcessCapacity         | 7.90       | -4.08| -6.34| -6.46| -18.09| -2.46| -2.62| -7.09| -12.78|
|                        | (6.027)    | (6.627)| (5.766)| (5.677)| (4.726)| (6.539)| (6.256)| (4.457)| (7.999)|
| OtherSubExcessCapacity | 2.52       | 3.73 | 3.82 | 4.14 | -0.79 | 3.68 | 4.10 | 4.52 | 1.40  |
|                        | (0.469)    | (0.516)| (0.644)| (0.200)| (0.878)| (0.775)| (0.444)| (0.130)| (0.835)|
| SubmarketDensity       | -0.18      | 0.65 | -0.19| 3.27 |       |       |       |       |       |
|                        | (0.297)    | (0.625)| (0.347)| (0.894)|       |       |       |       |       |
| tSubmarket1            |            |      |      |      | 0.01  |      |      |      |      |
|                        |            |      |      |      | (0.005)|      |      |      |      |
| tSubmarket2            |            |      |      |      | 0.02  |      |      |      |      |
|                        |            |      |      |      | (0.044)|      |      |      |      |
| tSubmarket3            |            |      |      |      | 0.00  |      |      |      |      |
|                        |            |      |      |      | (0.005)|      |      |      |      |
| tSubmarket4            |            |      |      |      | 0.19  |      |      |      |      |
|                        |            |      |      |      | (0.013)|      |      |      |      |
| tSubmarket5            |            |      |      |      | -0.00 |      |      |      |      |
|                        |            |      |      |      | (0.016)|      |      |      |      |
| Constant               | 2.59       | 2.26 | 2.31 | 2.36 | 2.47 | 2.23 | 2.28 | 2.09 | 1.48  |
|                        | (0.759)    | (0.893)| (0.328)| (0.345)| (0.098)| (0.349)| (0.351)| (0.257)| (0.423)|
| Observations           | 100        | 100  | 100  | 100  | 100  | 85   | 85   | 80   | 80    |
| Number of submarket    | 5          | 5    | 5    | 5    | 5    | 5    | 5    | 4    | 4     |
| Submarket FE           | No         | No   | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes   |
| Year FE                | No         | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  | Yes   |
| R-squared within       | 0.30       | 0.46 | 0.47 | 0.47 | 0.69 | 0.40 | 0.40 | 0.50 | 0.59  |
| Variables              | Base model |        |        |        |        | Drop 2009–2011 |        |        | Drop discrete |
|------------------------|------------|--------|--------|--------|--------|----------------|--------|--------|--------------|
|                        | (1)        | (2)    | (3)    | (4)    | (5)    | (6)            | (7)    | (8)    | (9)          |
| R-squared between      | 0.22       | 0.18   | 0.19   | 0.30   | 0.35   | 0.29           | 0.46   | 0.49   | 0.06         |
| R-squared overall      | 0.01       | 0.00   | 0.00   | 0.01   | 0.03   | 0.00           | 0.02   | 0.01   | 0.20         |
| Degrees of freedom remaining | 97        | 78     | 78     | 77     | 73     | 66             | 65     | 58     | 57           |

Notes: Robust standard errors in parentheses.
| Variables                 | Greenfield entrants | Incumbent entrants | Submarket incumbents |
|---------------------------|---------------------|--------------------|---------------------|
|                           | (1) Drop 2009–2011  | (2) Drop discrete  | (5) Drop 2009–2011  | (6) Drop discrete  | (9) Drop 2009–2011  | (10) Drop discrete |
| ExcessCapacity            | –6.21               | –5.75              | –4.06               | –4.25              | –0.66              | –11.25              | –1.28              | –0.99              |
|                           | (5.579)             | (5.079)            | (6.688)             | (6.435)            | (7.061)            | (7.279)             | (6.400)            | (5.678)            |
| OtherSubExcessCapacity    | 2.90                | 1.74               | 3.91                | 4.40               | 4.27               | 1.24                | 0.53               | –0.22              |
|                           | (0.870)             | (0.516)            | (0.804)             | (0.268)            | (0.495)            | (0.934)             | (0.726)            | (0.467)            |
| SubmarketDensity          | 0.64                | 0.64               | –0.27              | –0.26              | 3.66               | 0.41                |                      |                    |
|                           | (0.172)             | (0.267)            | (0.353)             | (0.414)            | (0.983)            | (0.409)             |                      |                    |
| Constant                  | 0.85                | 0.67               | 2.17                | 2.24               | 2.17               | 1.27                | 0.96               | 0.85               |
|                           | (0.214)             | (0.223)            | (0.317)             | (0.343)            | (0.363)            | (0.384)             | (0.274)            | (0.302)            |
| Observations              | 100                 | 100                | 100                 | 100                | 100                | 100                 | 100                | 100                |
| Number of submarket       | 5                   | 5                  | 5                   | 5                  | 5                  | 4                   | 5                  | 5                  |
| Submarket FE              | Yes                 | Yes                | Yes                 | Yes                | Yes                | Yes                 | Yes                | Yes                |
| Year FE                   | Yes                 | Yes                | Yes                 | Yes                | Yes                | Yes                 | Yes                | Yes                |
| R-squared within          | 0.29                | 0.33               | 0.33                | 0.37               | 0.48               | 0.49                | 0.42               | 0.63               |
|                           | (0.02)              | (0.02)             | (0.02)              | (0.02)             | (0.02)             | (0.02)              | (0.02)             | (0.02)             |
| R-squared between         | 0.02                | 0.52               | 0.26                | 0.45               | 0.59               | 0.10                | 0.55               | 0.34               |
|                           | (0.01)              | (0.01)             | (0.01)              | (0.01)             | (0.01)             | (0.01)              | (0.01)             | (0.01)             |
| R-squared overall         | 0.10                | 0.41               | 0.00                | 0.02               | 0.03               | 0.25                | 0.01               | 0.27               |
|                           | (0.01)              | (0.01)             | (0.01)              | (0.01)             | (0.01)             | (0.01)              | (0.01)             | (0.01)             |
| Degrees of freedom remaining | 78                   | 77                 | 65                  | 57                 | 78                 | 77                  | 65                 | 57                 |

**TABLE A4** OLS regressions for entry diversion between submarkets (log of greenfield & incumbent entrants, submarket incumbents)