Strategic Management Journal
Strat. Mgmt. J., 34: 1531–1550 (2013)
Published online EarlyView 25 March 2013 in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/smj.2085
Received 28 October 2010; Final revision received 30 March 2012

# FAST-MOVER ADVANTAGES: SPEED CAPABILITIES AND ENTRY INTO THE EMERGING SUBMARKET OF ATLANTIC BASIN LNG

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*Entry timing benefits and costs typically vary with firms' capabilities. In this study, we empirically examine the entry timing implications of firms' intrinsic speed capabilities, which refer to the ability to execute investment projects faster than competitors. We hypothesize that firms with intrinsic speed capabilities face low preemption risks and, thus, can afford to wait longer for uncertainty resolution before deciding to enter new markets. This hypothesis is more applicable when investment is associated with higher levels of commitment and, thus, greater option value of waiting. A direct implication is that late entrants with intrinsic speed capabilities should have greater expected post-entry performance. We find support for these hypotheses in the Atlantic Basin liquefied natural gas (LNG) industry from 1996 to 2007.* Copyright © 2013 John Wiley & Sons, Ltd.

## INTRODUCTION

Firms face a complex problem in deciding when to enter a new submarket in an industry. First, market entry is a time-consuming process; in industries requiring large capital investment such as aircraft manufacturing, semiconductors, or chemicals, the development of new productive facilities for entry can take many years (Koeva, 2000; Pacheco-de-Almeida, Henderson, and Cool, 2008; Salomon and Martin, 2008). Given the time gap between the decision to enter a market and the completion of entry, a firm must evaluate how fast it can complete the entry process and then decide when to commence entry. Second, firms must weigh the opposing incentives involved in the timing of entry—the trade-off between early commitment versus flexibility in a new market opportunity. An early entrant faces less competition but may make costly mistakes due to a lack of information and learning opportunities, whereas late entrants can benefit from information revelation and learning opportunities but may face higher preemption costs (Lieberman and Montgomery, 1988, 1998; Ghemawat, 1991; Pindyck, 1991; Dixit, 1992; Mitchell, Shaver, and Yeung, 1994; Shaver, Mitchell, and Yeung, 1997; Ghemawat and del Sol, 1998). The resolution of this classic trade-off and, thus, firms' entry timing is clearly affected by a firm's ability to complete the entry process speedily.

This article focuses on the influence of firms' intrinsic speed capabilities on market entry decisions and the resulting entry performance implications. By *intrinsic speed capabilities*, we mean firms' ability to execute investment projects faster

Keywords: firm capabilities; first-mover advantages; new market entry; strategy dynamics; speed; project management
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than competitors at the same cost. Our basic premise is that firms with greater intrinsic speed capabilities face a lower risk of preemption because they can complete the market entry process faster than competitors. These firms can, therefore, afford to wait longer for uncertainty resolution before entering new markets than can slower firms. This relationship will be more likely when investment is associated with higher levels of commitment due to the greater option value of delaying entry to collect additional information. An immediate implication is that firms with greater speed capabilities will have higher expected entry performance. We empirically examine the validity of these ideas using the entry timing and performance of firms entering the new market opportunity of the Atlantic Basin liquefied natural gas (LNG) industry from 1996 to 2007.

LNG is an important area of the oil and gas industry with explosive growth over the last decade. The rise of natural gas prices and a new approach to the LNG business model in the Atlantic Basin has resulted in a boom in Atlantic Basin LNG investment, creating an appropriate setting to study differences in entry decisions into a new market opportunity. Our empirical context has several desirable features: (1) since the industry relies on a standardized technology, entry is not constrained by proprietary technology; (2) yet, the entry process in the industry is time consuming and often requires substantial irreversible investment; (3) there exists substantial variation in speed capabilities across entrants in the industry; (4) the industry has genuine learning opportunities and preemptive risks associated with delayed entry; (5) the market allows a clear *ex post* identification of a risky early-entry period and a less uncertain late-entry period which suits our empirical purpose; and, finally, (6) data on entry into LNG is publicly available.

## LITERATURE REVIEW

### The entry timing decision

Businesses entering a new market must conduct a multitude of tasks. Entrants must choose a site, coordinate construction of facilities, source needed inputs, hire workers, set up logistic networks, and gain an understanding of the idiosyncrasies of local consumers. Firms ideally would like to begin this entry process early to capture revenue streams sooner. However, the decision is complicated by the uncertainty inherently associated with a new market and by competition from other entrants. Accordingly, the incentives associated with the timing of entry vary due to two broad classes of factors: (1) learning and (2) preemption.

The incentives to delay entry stem from scant information and limited learning opportunities. The very early entrants face a market that may yet to be fully developed as well as a lack of examples to follow. With limited information and precedents, pioneers must make decisions related to the process of entry with high uncertainty in market conditions and in operational effectiveness. As a consequence, the very early entrants face a high probability of making irreversible and costly mistakes in choosing production sites, ramping up production facilities, sourcing inputs and workers, etc., in establishing operations (Glazer, 1985; Lieberman and Montgomery, 1988, 1998; Mitchell, 1989, 1991; Mitchell *et al.*, 1994). These mistakes may result in noncompetitive positioning, high operating costs and low sales opportunities which often lead to failures, as reported in Mitchell, Shaver, and Yeung (1992). In contrast, later entrants may benefit from waiting by collecting additional market and industry information as well as by learning from the successes and failures of earlier entrants (Zimmerman, 1982; Argote, Beckman, and Epple, 1990; Pindyck, 1991; Dixit, 1992; Mitchell *et al.*, 1994; Ingram and Baum, 1997; Shaver *et al.*, 1997; Kim and Miner, 2007). Thus, later entrants may be able to make more informed decisions about when to commence entry and how to execute the entry process.

Countering the learning benefits in delayed entry are market preemptive pressures. Late entrants are likely to face difficulties in ramping up operations and executing the critical tasks that are part of market entry due to the presence of entrenched competitors in the market (Mitchell *et al.*, 1994; Ghemawat, 1991; Lieberman and Montgomery, 1988, 1998). For instance, in choosing a production site, late entrants may not be able to obtain prime locations because earlier entrants have taken up good sites. To hire workers, late entrants must pay higher wages to pry workers away from established competitors. To source scarce inputs, late entrants must outbid competitors to establish privileged partnerships with specific suppliers. To gain market share, late entrants must



DOI: 10.1002/smj

disrupt existing consumer-producer relationships, requiring the firm to compensate consumers with lower prices to overcome switching costs. These examples correspond to the late entry penalties associated with preempted scarce assets, consumer preferences and switching costs documented in the first-mover advantages literature (Lieberman and Montgomery, 1988, 1998).

### The endogeneity problem

Perhaps because of the complex trade-off between the benefits and costs of early entry, the strategy literature has yet to provide a clear picture about the link between entry timing and subsequent performance (see Franco *et al.*, 2009, and Finkelstein, 2002, for recent reviews). While numerous papers have suggested that there are performance advantages of committing to early entry (Fudenberg and Tirole, 1983; Ghemawat, 1991; Spence, 1979), other papers have emphasized performance advantages for maintaining flexibility and entering later (Kulatilaka and Perotti, 1998; McGrath, 1997, 1999; Luehrman, 1998).

Lieberman (2008: 5) explains this conundrum as follows: 'One general conclusion from the literature is that the net benefits of early entry are contingent upon a variety of industry and firm-specific factors ....[and the advantages of early entry] are frequently offset by higher costs or risks faced by the pioneer.' Indeed, a natural way to advance our understanding of entry timing is to recognize the existence of firm-level heterogeneity. Shaver *et al.* (1997), for example, pointed out that the learning benefits appear to be higher in firms that have greater ability to understand information emitted from pioneers' entry experiences.

This firm-level heterogeneity in the costs and benefits of entry timing endogenously affects firms' entry decisions. For example, if the net benefits of early versus late entry depend on firms' capabilities, firms will strategically pick their entry timing to take advantage of their capabilities vis-à-vis other entrants. Some firm capabilities may bestow advantages on an entrant during the early stages of a new market opportunity, whereas other capabilities may make later entry more favorable. This legitimate concern that firms' entry timing decision is endogenous is not entirely new. Some researchers have started focusing on organizational factors, such as learning capabilities, that moderate the effect of entry timing on performance. Notable examples of this type of work that have explicitly discussed the endogeneity of entry timing include Mitchell (1991), Mitchell *et al.* (1994), Shaver *et al.* (1997), and Franco *et al.* (2009).

In this article, we focus on firms' speed capabilities, an idea that has not been studied in the empirical literature. Our basic point is that when market entry is associated with large and lengthy project development, intrinsic speed capabilities critically affect the choice of entry timing and subsequent entry performance. Several studies indicate that speed gives firms a competitive advantage (Stalk, 1988; Stalk and Hout, 1990; Teece, 2007; Teece, Pisano, and Shuen, 1997; Barnett and Hansen, 1996; Helfat *et al.*, 2007; Pacheco-de-Almeida, Hawk, and Yeung, 2010). Our work adds a new angle on the nature and performance implications of such an advantage. Next, we discuss this role of intrinsic speed capabilities in market entry timing decisions.

## HYPOTHESES

By *intrinsic speed capabilities*, we mean firms' ability to execute investment projects faster than competitors at the same cost.[1] For two firms entering a new market at the same time, the firm with greater speed capabilities has a higher probability of getting a good site, hiring high quality employees available in the market, locking up good suppliers, and obtaining a customer base yet unclaimed by competitors. It can also establish sales networks, production, logistic systems, and organizational arrangements faster and, thus, reduce the risks of being preempted. In other words, firms with intrinsic speed capabilities have lower preemption costs. This has important implications on a firm's decision on entry timing.

When entry into an uncertain new market requires a large irreversible investment, a potential entrant must choose its entry timing by balancing

[1] Numerous organizational factors can lead to a firm becoming intrinsically faster at project execution. In our field work, one oil and gas industry consultant explicitly explained that an organization that has an outcome-oriented culture and is able to navigate the regulatory environment can speed up plant development. Trade journals have also stressed the importance of superior engineering expertise (*Oil & Gas Journal*, 1990; Ganapati, Ding, and Mooley, 2000). Further examples of intrinsically faster firms and additional discussion can be found in Pacheco-de-Almeida *et al.* (2010).

the benefits of additional learning from delayed entry with the costs associated with preemption. In these settings, intrinsically faster firms should have an important advantage: since speed capabilities reduce the costs from preemption, an intrinsically faster firm can afford to wait longer, observe more, and, thus, benefit more from learning. Accordingly, the possession of speed capabilities should result in a later market entry time, *ceteris paribus*. This prediction finds support in the formal economic literature (Bar-Ilan and Strange, 1996) and is consistent with the notion of a 'fast follower' strategy (Baldwin and Childs, 1969; Markides and Geroski, 2005), where we equate being 'fast' with possessing above average speed capabilities in investment project execution. Our hypothesis is predicated on the irreversible nature of firms' investments. In this article, we define irreversible investments as usage-specific investments that are useful for little else than their original intended purpose—or that have financially unattractive alternative applications. In these circumstances, the value of the option to wait is high, and firms with intrinsic speed capabilities are likely to delay entry.[2]

> *Hypothesis 1 (entry timing): Intrinsically faster firms enter uncertain new markets later than slower firms when investments are usage specific.*

## Performance implications

Our theoretical premise is that firms endogenously decide on their entry timing based on their own set of intrinsic speed capabilities in order to enhance performance. This implies the following relationship among intrinsic speed capabilities, entry timing, and subsequent entry performance:

$$\Pi_{j,t} = \beta_0 + \sum_{P=1,2} \beta_P \left(Speed\ \ Capability_{j,t} \times\ Entry\ Timing_P\right) + \boldsymbol{\beta_3 X_j} + \varepsilon_{j,t} \qquad (1)$$

where $\prod_{j,t}$ is a measure of profitability from entry, $Entry\ Timing_p$ are dummies indexed by $P = 1,\ 2$ indicating entry during the early ($P = 1$) or late ($P = 2$) regime of a new market opportunity, $Speed\ Capability_{j,t}$ is a measure of the intrinsic speed capabilities of the firm, and $\boldsymbol{X_j}$ is a set of firm and industry effects to control for other firm and industry heterogeneity. When market conditions are uncertain in the early regime, we argue that faster firms that have the ability to wait, collect additional information, and learn from prior entrants at a lower cost should perform better by waiting—that is, $\beta_2 > \beta_1$ and $\beta_2 > 0$. These predictions are consistent with prior literature on the performance implications of intrinsic speed capabilities (Pacheco-de-Almeida *et al.*, 2010) and with the notion of 'fast follower' strategy (Baldwin and Childs, 1969; Markides and Geroski, 2005).[3]

As discussed when we presented Hypothesis 1, our line of reasoning applies when the value of the option to wait is high, which is the case when investments are irreversible or usage specific. In contrast, when investments are usage flexible, the advantages of waiting are limited and, thus, late entry by intrinsically faster firms should not have significant performance implications. This prediction is summarized in our next hypothesis.

> *Hypothesis 2 (fast-mover advantages): Intrinsically faster firms that enter uncertain new markets later outperform all other entrants when investments are usage specific.*

For clarity purposes and consistent with Hypothesis 2, we further differentiate the performance implications of entry timing with intrinsic speed capabilities, $\beta_p$, as follows:

$$\beta_P = \beta_P^S Usage|Specific + \beta_P^F Usage|Flexible \qquad (2)$$

where $Usage|Specific$ and $Usage|Flexible$ are mutually exclusive dummies indicating whether

[2] In contrast, when investments are more usage flexible and firms can easily revise or redeploy their investments to alternative uses with minimal loss in revenues, the value of the option to delay entry is low.

[3] Pacheco-de-Almeida *et al.* (2010) show that, generally, intrinsic speed capabilities enhance firm value. Our current work focuses on one source of value augmentation: firms can take advantage of their speed capabilities to delay market entry as they wait for information revelation that enhances firm performance. As will be discussed later, we build upon Pacheco-de-Almeida *et al.*'s (2010) methodology to develop an instrument for intrinsic speed capabilities.

entry is associated with a usage-specific or usage-flexible investment. Substituting Equation 2 into Equation 1 gives us the following equation to test the contingencies of a fast-follower strategy:

$$\prod_{j,t} = \beta_0 + \sum_{p=1,2} (\beta_P^S Speed\ \ Capability_{j,t} \times Entry\ \ Timing_p \times Usage|Specific + \beta_P^F Speed\ \ Capability_{j,t} \times Entry\ \ Timing_p \times Usage|Flexible) + \boldsymbol{\beta_3 X_j} + \varepsilon_{j,t} \tag{3}$$

Since the performance benefits from delayed entry should be larger with high usage specificity, we predict that $\beta_2^S > \beta_1^S$ and $\beta_2^S > 0$. Finally, the performance benefits from delayed entry with usage-flexible investments are uncertain.

## RESEARCH DESIGN

### Sample

We examine the empirical relationship between speed capabilities, entry timing, and subsequent entry performance in the context of the Atlantic Basin LNG submarket of the global LNG industry from 1996 to 2007. To save space, we report in Appendix I background information on the LNG industry and the emergence of the Atlantic Basin submarket as a new market opportunity—and its special features that make it an attractive context for our study. We mention here two critical features that are pertinent to our study.

First, we ground our study of new market entry decisions using the broad empirical patterns of the emergence of new market opportunities as depicted in studies on industry evolution (Gort and Klepper, 1982; Agarwal and Gort, 1996). According to this literature, the early stage of an industry tends to be characterized by two phases: Phase I, where entry is slow, and Phase II, where entry accelerates until reaching a peak. The boundary between Phase I and Phase II usually is determined by ‘a sharp increase in the rate of entry of new competitors into the industry’ (Gort and Klepper, 1982: 631), and this increase in entry is typically associated with some introduction of new ‘information emanating from sources outside the set of current producers’ (Gort and Klepper, 1982: 632) that facilitates entry. As presented in Figure 1 and discussed in the Appendix, construction activity in Atlantic Basin LNG closely follows these patterns. Entry occurred from the mid-1990s to 2000

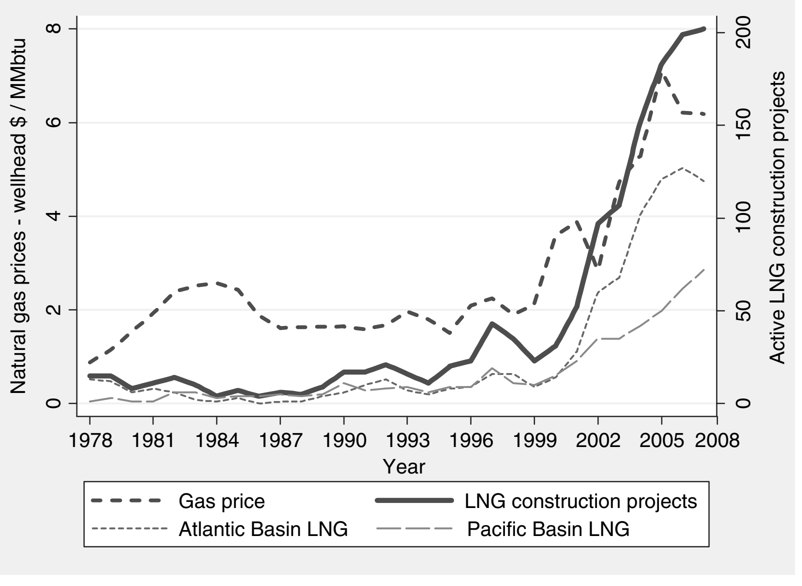


Figure 1. Global liquefied natural gas (LNG) industry, 1978-2007
Notes: Monthly U.S. natural gas wellhead price data was obtained from the Energy Information Administration of the U.S. Department of Energy. LNG construction activity information comes from our data collection efforts described in the Data section.




DOI: 10.1002/smj

at a very slow rate when natural gas prices were historically low and the market was uncertain. In the winter of 2000, following market liberalization and increase in demand, natural gas prices surged upward to more than five times the typical price level and a consensus of uncertainty reduction developed. Entry dramatically accelerates in the Atlantic Basin LNG market until the end of our sample (with a slight reduction in entry in 2007). As a result, we partitioned the entry queue based on a pre-2000 highly uncertain regime (corresponding to Phase I) and a post-2000 regime with an empirically validated and exogenously determined uncertainty reduction (corresponding to Phase II). Note that we use the change in LNG pricing in 2000—and not the market diffusion of technological information (as in Gort and Klepper, 1982)—as the boundary between Phases I and II because LNG is a commodity market with limited product innovation.

Second, our empirical hypotheses build on usage specificity. An ideal proxy for usage flexibility is difficult to obtain. Fortunately, we can partition our sample by facility type: gasification versus liquefaction facilities. Gasification facilities are usage specific due to the minimal return available if the chosen import market does not become economically viable. Liquefaction facilities are usage flexible since the LNG output from liquefaction can be diverted and sold in other markets—given the multiple alternatives, the value of the investment is less critically dependent on the development of the original intended use. Our empirical hypotheses apply to gasification investments due to the high level of usage specificity.

## Data

Our main source of data on entry into LNG is the worldwide LNG construction projects data set from the *Oil & Gas Journal (OGJ)*. We supplemented this data with other sources on LNG projects and project ownership from the *LNG Observer*, the 2007 LNG World Trade poster produced by the OGJ and the Gas Technology Institute, the Energy Information Administration's (EIA) 2003 report *The Global Liquefied Natural Gas Market: Status & Outlook*, Tusiani and Shearer's (2007) *LNG: A Nontechnical Guide*, and company Web sites. This data collection effort produced a data set of 352 LNG projects from 1996 to 2007, and it represents an exhaustive database of all construction activity in LNG during our period of analysis.[4] We then mapped this entry information to the firm-year, parent company level using the ownership information collected during our data work. We matched this data with hand-collected information on parent company oil and gas reserves from the OGJ100/200 (the OGJ's survey of the 100 leading U.S.-based and 200 leading international oil and gas companies) and company annual reports and 10-Ks, LNG tanker information from the *LNG Observer* and the EIA, financial information from the OGJ100/200, Orbis, Compustat and company filings, project execution data unrelated to LNG from the OGJ, and LNG experience data spanning to the beginning of the industry in the 1960s from the OGJ. After deleting observations due to missing data for needed covariates, our final sample contained a panel data set over 12 years, from 1996 to 2007 and produced a sample of 585 firm year records corresponding to 50 firms. We believe this data set comprises a comprehensive and unique panel data set of all entrants into Atlantic Basin LNG with available and useable data for covariates.

### Dependent variable: entry decisions

To study entry decisions, we create a series of dependent variables that equal '1' if a firm begins an LNG facility in a given year and '0' otherwise. We define entry as the initiation of a liquefaction or gasification project [$LNG|Entry$]. We further differentiate entries by liquefaction [$LIQ|Entry$] and gasification [$GAS|Entry$] projects.

### Dependent variable: entry performance

To measure entry performance, we construct *CAR* as the cumulative abnormal stock market return at

[4] Our goal was to construct a comprehensive data set of all worldwide LNG construction projects from the mid-1990s to the present. We chose to begin our sample in 1996 since it corresponds roughly with the beginning of the emergence of the Atlantic Basin LNG new market opportunity, and it is also the year that marks the beginning of the first construction project of a liquefaction plant in the Western Hemisphere designed to target Atlantic Basin import markets (the Atlantic LNG project in Trinidad and Tobago). We have collected LNG project data worldwide as far back as the early 1970s, and we use this data for construction of the experience variables in our analysis. However, we exclude these earlier years from our analysis since Atlantic Basin LNG did not start to emerge as a new market opportunity until the mid-1990s. Our speed measure is also available only from 1996 onward, restricting us to 1996 and later.

the time when a firm announces entry with an LNG facility. To construct *CAR*, we first conduct the following data work: for each LNG project in our data set, we identify the date of announcement for each LNG project using Factiva and Lexis-Nexis. We merge these announcement dates with stock market return data from CRSP. After cleaning our data, we have 291 global LNG projects with a useable announcement date and available stock price information. When we restrict our analysis to the Atlantic Basin, our data on projects in the Atlantic Basin with available corresponding U.S. stock market information from CRSP gives us a sample of 185 events. Several firms, however, have repeat observations when they enter into more than one project in the Atlantic Basin in a given day. To avoid double counting these observations in our analysis, we drop 14 duplicate observations and end up with a sample of 171 events.

We then use standard event study methodology, as in Brown and Warner (1980), to estimate a three-day event window [−1, +1] cumulative abnormal stock market return when a firm announces entry with an LNG facility. Specifically, we first estimate the expected stock market return for each company using OLS as: $RET_{j,t} = \alpha + \beta_j VWRETD_t + \varepsilon_{j,t}$. In our estimation, $RET_{j,t}$ is the daily stock return series for firm j and $VWRETD_t$ is the daily value weighted market index return series from CRSP. The parameters are estimated using a 200-day window of stock market data 50 days prior to the announcement date [−250, −50). The regression gives us the expected stock market return $\widehat{RET}_{j,t}$ during an event window surrounding the day the firm announces entry into LNG. We then calculate the abnormal stock market return for the firm during the event window by subtracting the predicted return from the actual return: $AR_{j,t} = RET_{j,t}\text{-}\widehat{RET}_{j,t}$ The cumulative abnormal return *CAR* is the abnormal stock market return over the event window [−1, +1].

### Main independent variable: speed capability

The central explanatory variable, *Speed Capability*, is the measure of the intrinsic speed capabilities of the firm in a given year. To construct our measure of speed capabilities, we faced several requirements: (1) since intrinsic speed capabilities in LNG project development is unobserved, we required a proxy that is highly correlated with the unobserved variable; and (2) the measure should be uncorrelated with other unobserved factors related to entry decisions into LNG to avoid endogeneity.

To meet these criteria, we construct an entirely separate data set of oil and gas construction projects unrelated to LNG. A proxy for speed capabilities based on LNG projects would likely be correlated with other unobserved factors associated with the evolution of the LNG industry, such as preemption and information revelation (i.e., learning opportunities). By using data from construction projects that exist independently from the LNG submarket, our proxy of speed capabilities has less of an endogeneity problem. Finally, we need to be confident that our proxy for speed capabilities based on projects unrelated to LNG is highly correlated with intrinsic speed capabilities in LNG project execution. Oil and gas firms typically have internally shared management processes, cultures, and capabilities that determine project development speed across project type and submarkets. An example is CHPDEP, the Chevron Project Development and Execution Process. Chevron applies this process to all large investment projects across submarkets, implying that Chevron's speed capabilities should be present in different submarkets and highly correlated. ExxonMobil also has a common project management culture across submarkets that stresses outcome metrics and accountability. This evidence suggests that our *Speed Capability* proxy based on oil and gas project data should be highly correlated with intrinsic speed capabilities in LNG project development.[5]

Our data set of projects unrelated to LNG comes from the *Oil & Gas Journal*. Our data covers 4,782 projects on refining, petrochemical, gas processing, pipeline, and sulfur facility construction projects across 105 countries from 1995 to 2007. These facilities are independent from the liquefied natural gas subindustry. In order to obtain histories of each project and corresponding measures of time-to-build, we follow the development of each project across issues of the *Oil & Gas Journal*. Our measure of time-to-build is the lag between the

[5] To verify, we collected data on completed LNG projects and created an LNG-based speed measure for comparison. The pairwise correlation coefficient between a speed measure based on projects unrelated to LNG and an LNG-based speed measure is 0.393 ($p = 0.071$). Our instrument does not appear to be weak.

start and end dates of plant development reported in the OGJ.[6] We then map each project to its main parent using the *Directory of Corporate Affiliates*, the ownership data in the Orbis data set from the Bureau van Dijk, and Internet searches.

We conceptualize intrinsic speed capabilities as the ability of the firm to complete investment projects faster than the industry average. To create our measure of intrinsic speed capabilities, we use the same general approach to measure firm speed as in Pacheco-de-Almeida *et al.* (2010). In this approach, we decompose the time-to-build of each project into a systematic component and an idiosyncratic component (corresponding to the degree to which firms are faster or slower than systematic average). Specifically, we pull project-level data from all firms for all facilities (indexed by $f$), all geographic regions (indexed by $l$), all industries (indexed by $i$), and all years (indexed by $t$) in our sample to run the following regression:[7]

$$\ln \widetilde{T}_{f,i,l,t} = \beta_1 \ln E_{f,i,l,t} + \beta_2 \ln \overline{\Delta}_{l,t} + \overrightarrow{\beta_3} IDUM + \overrightarrow{\beta_4} LDUM + \overrightarrow{\beta_5} YDUM + \theta_{f,i,l,t} \quad (4)$$

where $\widetilde{T}_{f,i,l,t}$ is the time-to-build of the project, $E_{f,i,l,t}$ is the capacity of the project, $\overline{\Delta}_{l,t}$ is a proxy for the local demand growth, and *IDUM*, *LDUM*, and *YDUM* are, respectively, column vectors of industry, geographic region, and year dummies for the project. Intuitively, development times are positively associated with the size of a project and are usually compressed when the local market demand is fast growing. As well, they are affected by year-, industry-, and country-specific factors (e.g., bureaucratic delays). Following Pacheco-de-Almeida *et al.* (2010), we discount our measure of time-to-build with estimates of the industry discount rate. The industry discount rate ($r$) is proxied by the average WACC (weighted average cost of capital) across all oil and gas companies with Compustat-CRSP merged financial data from 1996 to 2005.[8,9] We obtain capacity figures using OGJ data (in volume and mass units). Local demand growth ($\overline{\Delta}_{l,t}$) is proxied by the yearly growth rate in real GDP in the country of the project from the World Bank Development Indicators database.

The estimated residual $\theta_{f,i,l,t}$ associated with a project for a given firm (denoted $\theta^{j}_{f,i,l,t}$ for firm $j$) from our estimation of Equation 4 represents the idiosyncratic component of the time-to-build that is uncorrelated with the systematic determinants of time-to-build associated with capacity, demand condition, time fixed effects, and industry and geographic regional fixed effects. A negative residual implies the project was finished faster than average, whereas a positive residual indicates the opposite.

We use this measure of project speed to create a measure of firm speed. First, for comparability, we

[6] Our measure of the time-to-build is reported in months. We assume that the official start (end) of plant development is the date in which the project is first (last) reported in the OGJ minus (plus) 90 days. We use the 90-day lag due to the fact that the OGJ reports the status of each plant development project only twice per year, in April and October. As a result, when a project appears for the first time in the OGJ, we can infer only that the investment project started sometime after the prior issue and before the current one. For simplicity, we assume that development started exactly in-between the two consecutive issues of the OGJ and, thus, use the 90-day lag (three months). We use the same logic with the official end date of the project. In cases where an expected completion date was reported, we use this expected completion date as the official end date.

[7] We place each project in a subgroup based on geographic region and industry type. For convenience, we use $i$ to index industry and $l$ to index region. For industry type, the subgroups are based on facility type: refineries; petrochemicals; pipelines; gas processing; and sulfur. For geographic region, we use the following: Asia and the Pacific; Eastern Europe; Former USSR; Japan; Latin American and the Caribbean; North Africa and the Middle East; North America; Sub-Saharan Africa; and Western Europe.

[8] We construct a universe of firms operating in the oil products industry (SIC code 29) and the chemical industry (SIC code 28) excluding pharmaceuticals (SIC code 283) during our period of analysis using Compustat-CRSP Merged financial data in order to approximate the industry discount rate. For each company, we construct the weighted average cost of capital (WACC) as a weighted average between the Equity Cost of Capital (ECC, proxied by the Earnings Yield = Earnings Per Share / Year End Price) and the Debt Cost of Capital (DCC = Interest Expense / (Long-Term Debt + Current Liabilities)) using market capitalization as weights. Expressed formally, we have that $\text{WACC} = \text{ECC}^* \frac{\text{Market Capitalization}}{\text{Market Capitalization+Long-Term Debt+Current Liabilities}} + \text{DCC}^* \frac{\text{Long-Term Debt+Current Liabilities}}{\text{Market Capitalization+Long-Term Debt+Current Liabilities}}$. We then subtract out the inflation rate (calculated using the growth rate in the CPI-U from the Bureau of Labor Statistics) in order to approximate the real discount rate).

[9] The functional form of the discounting is $\widetilde{T}_{f,i,t} = \left(1 - e^{-rT_{f,i,t}}\right)/r$, where $T_{f,i,t}$ is the measure of time-to-build in months before discounting. This functional form comes from the formal modeling work in Pacheco-de-Almeida *et al.* (2010). Developments times are distributed on $(0,\infty)$. The positive monotonic transformation compresses the distribution of development times from the infinite interval $(0,\infty)$ to the finite interval $(0, 1/r)$.



DOI: 10.1002/smj

have to standardize the measure. We calculate the mean and standard deviation of $\theta^j_{f,i,l,t}$ within each industry-region subgroup for each year, where the mean is calculated as $\overline{\theta}_{i,l,t} = \frac{\sum_j \sum_f \theta^j_{f,i,l,t}}{n_{i,l,t}}$ and the standard deviation is calculated as $\sigma_{i,l,t} = \left[\frac{\sum_j \sum_f \left(\theta^j_{f,i,l,t} - \overline{\theta}_{i,l,t}\right)^2}{n_{i,l,t}-1}\right]^{\frac{1}{2}}$. We then standardize each observation of $\theta^j_{f,i,l,t}$ (denoted $\widetilde{\theta}^j_{f,i,l,t}$) using $\overline{\theta}_{i,l,t}$ and $\sigma_{i,l,t}$ as follows: $\widetilde{\theta}^j_{f,i,l,t} = \frac{\theta^j_{f,i,l,t} - \overline{\theta}_{i,l,t}}{\sigma_{i,l,t}}$. Next, we build our measure of firm speed for firm $j$ by summing up the standardized project speed measure $\widetilde{\theta}^j_{f,i,l,t}$ for all of the projects that firm $j$ completes in year t and taking the average. Finally, we reverse code this measure so positive values indicate a faster firm. Formally, $\Theta^{\mathrm{j}}_{\mathrm{t}} = -\left(\sum_{f,i,l} \widetilde{\theta}^j_{f,i,l,t}\right)/\mathrm{n}^{\mathrm{j}}_{\mathrm{t}}$ is the average standardized investment speed of all $\mathrm{n}^{\mathrm{j}}_{\mathrm{t}}$ projects completed by firm $j$ at time $t$.

We then adjust our speed measure to fit a panel of firm-year observations. Our goal is to have a firm speed measure that accurately reflects the speed capabilities of the firm over time. Thus, we take the following approach: first, we define our measure of firm speed $Speed\ Capability_{j,t}$ as the moving average of $\Theta^{\mathrm{j}}_{\mathrm{t}}$ over the current year and the prior two years. Thus, $Speed\ Capability_{j,t} = \sum_{y=t-2}^{t} \Theta^{\mathrm{j}}_{\mathrm{y}}/3$. Second, we carry forward our speed measure to future years when no new information is available. Finally, for years in our panel before any speed information is available for a firm, we assume neutral speed (i.e., we replace $Speed\ Capability_{j,t} = 0$ for the remaining missing observations).

## Controls

Numerous other firm characteristics—such as firm size, age, prior experience in related markets (Fuentelsaz, Gomez, and Polo, 2002), and the possession of required supporting assets (Mitchell, 1989, 1991)—may affect entry incentives. *Firm Size* is the natural log of the average total sales of the firm from 1996 to 2007, deflated to 1996 prices using the consumer price index and averaged over the sample. *Age* is the difference between the year of incorporation for the firm and the event year, and *Age*$^2$ is included to account for possible nonlinear effects. To reduce potential multicollinearity between the age and age squared terms, we standardize the age measures. Our results do not change substantially with the exclusion of the age squared term. *Experience* is a count variable measuring the number of prior LNG projects that a firm has participated in over the course of the LNG industry. We include several measures of relevant complementary assets for the LNG submarket. We construct *Tankers* as the number of LNG tankers possessed by the firm. We create *Oil and Gas Production* and *Oil and Gas Reserves* as the natural log of the average oil and gas production and reserves of the firm from 1996 to 2007, respectively, measured in millions of barrels of oil equivalent (MMboe).[10,]

Investment incentives also matter. Growth in demand, capacity utilization, market share, and rival expansion has been found to induce investment, whereas investment lumpiness reduces the incentives to enter (Lieberman, 1987a, 1987b; Gilbert and Lieberman, 1987; Henderson and Cool, 2003a, 2003b; Pacheco-de-Almeida *et al.*, 2006). *Demand* is the four-year compound annual growth rate of worldwide LNG liquefaction and gasification. *Capacity Utilization* is annual LNG import and export volumes divided by operational LNG capacity (liquefaction plus gasification). Following prior literature (Lieberman 1987a), *Investment Lumpiness* is the multiplicative inverse of the total number of operational LNG facilities. We measure market share as the total capacity of a firm's LNG facilities divided by global LNG capacity: *LNG Export Market Share* for liquefaction facilities, and *LNG Import Market Share* for gasification facilities. *Rivals' Expansion* is the total LNG capacity announced by rivals to be added in a given year (liquefaction plus gasification) divided

[10] Firms with large oil and gas reserves and production rates are likely to possess greater financial resources and market power in hydrocarbon resource acquisition, processing, and distribution. Additionally, these firms should also have larger staffs of industry professionals with knowledge of the oil and gas industry. These industry-specialized assets may be useful in Atlantic Basin LNG by conferring a greater reputation in the natural gas market (facilitating contract execution during entry into Atlantic Basin LNG), and they may give firms a head start in the entry process (engineers on staff that may be willing to switch to LNG). As an additional consideration, oil and gas production may also serve as a proxy for firm differences in expectation on energy prices. Firms with more bullish beliefs in oil and natural gas prices should be more likely to produce more oil and gas, implying a high correlation between unobserved price expectation and observed oil and gas production.



DOI: 10.1002/smj

by total operational LNG capacity (liquefaction plus gasification).

We also include a set of industry dummies to account for any systematic differences in entry incentives across parent industry categorization. These include *Oil and Gas Extraction* (SIC code 13), *Petroleum and Coal Products* (SIC code 29), *Electric and Gas Services* (SIC code 49), and *Other*. A summary description and data source for each control variable is outlined in a table in Appendix II.

### Statistical method

#### *Event history analysis*

In the discrete time event history analysis (Allison, 1984, 2004; Shan and Song, 1997), we estimate a logit model predicting the probability of entry for each year (Allison, 1984, 2004) using annual data on whether a firm chooses to enter the LNG industry. The dependent variable is binary (equal to '1' if an entry occurs in a year) and allows for multiple entry events per firm over the history of the sample. Our risk set of potential entrants is defined as all oil and gas firms existing in a particular year that have participated in the LNG industry at some point over the history of the industry with available data for our covariates. In estimating the predicted probability of entry for each year, we include the aforementioned controls and our focal independent variable (*Speed Capability*). We choose the discrete time event history analysis rather than continuous time methods because the former is more appropriate when there is ambiguity about the time origin (Allison, 2004). Since the growth of the Atlantic Basin LNG submarket started roughly in the mid-1990s, we do not have an exact starting time for use in continuous time methods. Additionally, discrete time event history methods handle both time-dependent covariates, ties, and coarsely measured event times well (Allison, 2004), and our data is indeed grouped in an annual basis with coarse entry times. Since many firms enter multiple times over the history of the sample, entry events are repeatable and multiple observations for a single firm are not independent. We, therefore, use standard errors robust to clustering by firm.

#### *Event study*

We use an event study to examine entry performance. Strategy research has frequently used event studies to estimate value from firm heterogeneity in strategic actions (e.g., Morck and Yeung, 1992; Anand and Khanna, 2000; Benson and Ziedonis, 2009). In our study, we examine how the stock price reaction to news of a firm's entry into a market depends on the entrant's chosen entry timing and the entrant's intrinsic speed capability. The methodology relies on the stock market as an information processor, collecting relevant information about a corporation and its action. Informed trading, upon the arrival of news of a market entry, leads to a change in firm value that reflects the discounted value of the action. Variations in the stock price reactions across firms for a similar strategic action, therefore, are associated with relevant firm heterogeneity. An attractive feature of an event study is that the method allows causal linkage going from intrinsic speed capabilities to the stock market's assessment of future value creation.

To conduct the event study, we change our level of analysis from the firm-year level to the project announcement level. We create a data set of announcement dates of each project and we link these dates to stock price data on the days surrounding the announcement. As discussed earlier, we obtain the cumulative abnormal stock price return (*CAR*) of each company associated with the announcement of entry into LNG. We regress *CAR* onto our measure of intrinsic speed capabilities (*Speed Capability*), interacted with dummies indicating whether the entry is in the early, more uncertain regime before the end of 2000 (Phase I) or in the later, less uncertain regime after 2000 (Phase II), as specified in Equation 1. We further differentiate the relationship between *CAR* and intrinsic speed capability according to entry timing and whether the investment is usage specific or usage flexible, as in Equation 3. To control for any other influences on the stock price reaction of firms related to firm and parent industry heterogeneity, we include firm fixed effects and industry fixed effects.

## RESULTS

### Entry decisions

We present summary statistics and a correlation matrix for the data set in Table 1. We find that our measure of speed capabilities (*Speed Capability*) is positively correlated with entry. The other

Table 1. Descriptive statistics and correlation matrix for all years

| Variable | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. LNG\|Entry | 0.22 | 0.41 | 1 | | | | | | | | | | | | | | | | |
| 2. GAS\|Entry | 0.14 | 0.35 | 0.77 | 1 | | | | | | | | | | | | | | | |
| 3. LIQ\|Entry | 0.11 | 0.31 | 0.65 | 0.15 | 1 | | | | | | | | | | | | | | |
| 4. Speed Capability | −0.05 | 0.55 | 0.07 | 0.08 | 0.00 | 1 | | | | | | | | | | | | | |
| 5. Sales | 22.82 | 2.34 | 0.21 | 0.11 | 0.22 | 0.02 | 1 | | | | | | | | | | | | |
| 6. Age | 0.03 | 0.98 | 0.17 | 0.19 | 0.03 | 0.07 | 0.47 | 1 | | | | | | | | | | | |
| 7. Age$^2$ | 0.96 | 1.04 | 0.13 | 0.19 | 0.00 | −0.01 | 0.16 | 0.52 | 1 | | | | | | | | | | |
| 8. LNG Tankers | 2.34 | 6.90 | 0.16 | 0.08 | 0.20 | 0.04 | 0.28 | 0.05 | −0.16 | 1 | | | | | | | | | |
| 9. Oil Gas Prod | 5.52 | 2.18 | 0.07 | 0.04 | 0.07 | −0.16 | 0.30 | −0.06 | −0.02 | −0.02 | 1 | | | | | | | | |
| 10. Oil Gas Reserves | 7.67 | 2.31 | 0.08 | −0.00 | 0.15 | −0.01 | 0.72 | 0.08 | −0.03 | 0.09 | 0.39 | 1 | | | | | | | |
| 11. LNG Experience | 3.88 | 5.62 | 0.33 | 0.28 | 0.25 | −0.01 | 0.40 | 0.31 | 0.19 | 0.46 | 0.19 | 0.25 | 1 | | | | | | |
| 12. Import Mshare | 0.28 | 0.99 | 0.02 | 0.03 | 0.00 | 0.02 | 0.05 | 0.05 | −0.21 | 0.03 | −0.01 | −0.13 | 0.04 | 1 | | | | | |
| 13. Export Mshare | 1.60 | 3.56 | 0.11 | 0.07 | 0.12 | −0.06 | 0.22 | 0.03 | −0.07 | 0.28 | 0.20 | 0.41 | 0.48 | −0.09 | 1 | | | | |
| 14. LNG Demand | 7.49 | 0.83 | −0.04 | −0.02 | −0.04 | −0.02 | −0.00 | −0.05 | 0.01 | 0.06 | −0.00 | 0.00 | 0.23 | 0.03 | −0.01 | 1 | | | |
| 15. Capacity Util. | 46.61 | 4.70 | 0.12 | 0.16 | 0.00 | 0.01 | −0.01 | 0.07 | 0.02 | 0.09 | −0.00 | −0.00 | 0.34 | 0.05 | −0.01 | 0.63 | 1 | | |
| 16. Lumpiness | 91.17 | 14.35 | −0.12 | −0.16 | 0.00 | −0.01 | 0.01 | −0.07 | −0.02 | −0.09 | 0.00 | 0.00 | −0.34 | −0.05 | 0.01 | −0.65 | −0.99 | 1 | |
| 17. Rival Entry | 19.14 | 15.40 | 0.24 | 0.23 | 0.11 | 0.04 | −0.00 | 0.03 | −0.00 | 0.04 | −0.01 | 0.00 | 0.14 | 0.03 | −0.01 | −0.10 | 0.48 | −0.49 | 1 |

correlations between entry and our controls are, for the most part, consistent with prior findings in the literature. Of course, this analysis omits any control variables to partial out other influences that may affect the correlation coefficients. We also observe that the speed variable demonstrates substantial variation: a one standard deviation change in the speed variable (0.55) corresponds to a seven-month change in average project development time.

Statistics regarding multicollinearity were acceptable. Using variance inflation factors (VIFs) to examine potential collinearity in Table 1, we found that the only collinearity issue that may be of concern is with investment lumpiness and capacity utilization (VIF of 43.2 and 37.3, respectively). We expected potential collinearity issues with these variables since they both capture year-specific characteristics of the industry that may affect investment incentives. In our regression analysis, we include industry fixed effects to reduce any potential collinearity problem. We also repeat our analysis using year effects instead of these year-specific measures. Our results did not change substantially.

Table 2 presents results using a logit model predicting a firm's entry into the Atlantic Basin LNG market using standard errors robust to clustering by firm. As discussed earlier, we split the sample at the end of the year 2000. In Columns I and II, we treat entry as investment with either a gasification facility or with a liquefaction facility (*LNG|Entry*). We further partition our sample based on facility type: gasification facilities as usage specific and liquefaction facilities as usage flexible. Results for the former (*GAS|Entry*) are reported in Columns III and IV while those for the latter (*LIQ|Entry*) as reported in Columns V and VI.

We find support for our predictions regarding entry decisions in Columns I and II. When entry is defined as investment with either a gasification or liquefaction facility, we find that speed is unrelated to early entry (before the end of 2000) in Column I, but speed is positive and significantly related to later entry (after the end of 2000) in Column II. Thus, firms with greater intrinsic speed capabilities have a higher probability to entry after 2000 when more information was available and the general demand price level was more assuring. Still, we note that our results are only marginally significant at the 10 percent level during the post-2000

Table 2. Entry timing and speed capabilities using logit with clustering

| | I Atlantic Basin LNG 1996-2000 | II Atlantic Basin LNG 2001-2007 | III Atlantic Basin Gasification 1996-2000 | IV Atlantic Basin Gasification 2001-2007 | V Atlantic Basin Liquefaction 1996-2000 | VI Atlantic Basin Liquefaction 2001-2007 |
|---|---|---|---|---|---|---|
| Speed | 0.504 | 0.327* | 1.136 | 0.483*** | 0.205 | −0.359 |
| Capability | (0.486) | (0.174) | (1.153) | (0.175) | (0.591) | (0.414) |
| Firm Size | 1.171** | 0.245 | 1.641*** | 0.163 | 1.373** | 0.486 |
| | (0.479) | (0.191) | (0.522) | (0.155) | (0.571) | (0.335) |
| Age | −0.343 | −0.023 | −0.410 | 0.116 | −0.610 | −0.489 |
| | (0.390) | (0.234) | (0.321) | (0.198) | (0.550) | (0.641) |
| Age$^2$ | −0.297 | 0.222 | −0.061 | 0.409*** | −0.322 | −0.043 |
| | (0.288) | (0.197) | (0.310) | (0.151) | (0.378) | (0.395) |
| LNG | −0.083** | 0.021 | −0.105*** | 0.023 | −0.107** | 0.026 |
| Tankers | (0.042) | (0.018) | (0.036) | (0.019) | (0.043) | (0.031) |
| Oil & Gas | 0.003 | 0.052 | 0.230 | 0.094 | 0.892 | −0.265 |
| Production | (0.317) | (0.098) | (0.183) | (0.087) | (0.519) | (0.166) |
| Oil & Gas | 0.060 | −0.242 | −0.907** | −0.237 | 1.102 | 0.087 |
| Reserves | (0.354) | (0.168) | (0.381) | (0.149) | (0.672) | (0.317) |
| LNG | 0.048 | 0.093** | −0.127 | 0.056 | 0.233 | 0.102 |
| Experience | (0.103) | (0.041) | (0.094) | (0.035) | (0.151) | (0.063) |
| LNG Import | 0.318 | −0.095 | 0.097 | 0.029 | 0.995** | −0.203 |
| Market Share | (0.300) | (0.202) | (0.242) | (0.197) | (0.466) | (0.247) |
| LNG Export | 0.038 | 0.029 | 0.291** | 0.058 | −0.150 | −0.019 |
| Market Share | (0.112) | (0.079) | (0.121) | (0.077) | (0.162) | (0.111) |
| LNG | 0.651 | −0.605 | 0.365 | −0.557 | 3.045*** | −1.662** |
| Demand | (0.500) | (0.511) | (0.676) | (0.608) | (0.568) | (0.739) |
| Capacity | 8.341*** | −0.489 | 7.336*** | −0.915* | 9.268*** | 0.292 |
| Utilization | (1.500) | (0.339) | (2.592) | (0.488) | (1.104) | (0.558) |
| Investment | 1.520*** | −0.094 | 1.247** | −0.278 | 1.878*** | 0.159 |
| Lumpiness | (0.308) | (0.114) | (0.549) | (0.171) | (0.226) | (0.191) |
| Announced | 0.104 | −0.001 | −0.047 | −0.003 | 0.248*** | −0.025 |
| Rival Entry | (0.071) | (0.023) | (0.119) | (0.027) | (0.083) | (0.038) |
| Industry Dummies | Y | Y | Y | Y | Y | Y |
| N | 242 | 343 | 242 | 343 | 242 | 343 |
| Log-L | −63.969 | −163.859 | −38.981 | −140.005 | −38.941 | −89.236 |
| Prob > chi$^2$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Pseudo R$^2$ | 0.279 | 0.202 | 0.271 | 0.187 | 0.415 | 0.311 |

*** significant at 1%;
** significant at 5%;
* significant at 10%.
Results reported are from estimation of a logit model predicting entry into LNG in each year from 1996 to 2007. Standard errors robust to clustering by firm are reported in the parentheses. Industry dummies and a constant are included in the regressions, but results are not reported in the table.

regime, perhaps due to the dependent variable capturing both usage-specific (gasification) and usage-flexible (liquefaction) investments.

Further partitioning our results by facility types, we find more precise results. In Columns III and IV, where we explain entry with gasification facilities (which have high usage specificity), we find that speed is unrelated to entry before 2000 but very positively and significantly related to entry after 2000. The estimated speed coefficient in Column IV is positive and highly significant at the 1 percent level. Additionally, this estimated coefficient is much larger than our results for all facilities (it is 47.7% larger than in Column II). The corresponding marginal effect implies that a one standard deviation improvement in speed (seven-month acceleration) from average project development time increases the probability of



DOI: 10.1002/smj

entry in any year after 2000 by 23.4 percent. Thus, faster firms are waiting and entering later when entry is with high commitment gasification facilities.

Columns V and VI show that we do not find the same entry pattern for entry with liquefaction facilities (which have high usage flexibility). In fact, we obtain an insignificant relationship between entry with liquefaction facilities and speed capabilities. The estimated coefficients both before and after the end of 2000 are insignificant with a negative sign in the second period.

Clearly, our empirical results support that firms with intrinsic speed capabilities wait and time their irreversible usage-specific investment after uncertainty resolution.

The results for our controls in Table 2 are most consistent with the literature in the early, more uncertain regime. Bigger firms with higher market share tended to enter earlier, willing to make the large capital outlays to enter the market even when uncertainty was higher. During this period, higher capacity utilization tended to induce entry, perhaps reflecting the role of individual firms' market experience. But the result is less noticeable in the later regime when a positive marketwide sentiment on the feasibility of LNG investment has developed. Announced rival entry also provoked higher entry rates for liquefaction facilities in the earlier period, capturing the threat of preemption for firms investing in usage-flexible facilities.

## Entry performance

Using an event study, we find support for our predictions regarding entry performance. Table 3 displays these results, which include firm and industry fixed effects.

Column I investigates the role of entry timing in the relationship between investor expectation on entry performance and intrinsic speed capabilities. We expect that the performance enhancement from intrinsic speed capabilities should be higher for entry after uncertainties are more resolved. To test this prediction, we regress the CAR for entry on the interaction between the *Speed Capability* measure and dummies indicating entry with any kind of LNG Atlantic Basin facility during the early pre-2001 regime or late post-2000 regime. The coefficients in Column I on *Speed Capability* × *LNG|EarlyEntry* and *Speed Capability* × *LNG|LateEntry* show that intrinsic speed does

Table 3. Cumulative abnormal returns and speed capabilities in Atlantic Basin LNG

| | I<br>CAR | II<br>CAR |
|---|---|---|
| Speed Capability × LNG\|EarlyEntry | 0.008<br>(0.209) | |
| Speed Capability × LNG\|LateEntry | 0.021**<br>(0.011) | |
| Speed Capability × GAS\|EarlyEntry | | 0.010<br>(0.033) |
| Speed Capability × GAS\|LateEntry | | 0.025**<br>(0.012) |
| Speed Capability × LIQ\|EarlyEntry | | 0.004<br>(0.039) |
| Speed Capability × LIQ\|LateEntry | | 0.008<br>(0.021) |
| Firm Effects | Yes | Yes |
| Industry Effects | Yes | Yes |
| Constant | −0.037<br>(0.042) | −0.046<br>(0.044) |
| N | 171 | 171 |
| $R^2$ | 0.266 | 0.269 |

*** significant at 1%;
** significant at 5%;
* significant at 10%.
Results reported are from regressing the cumulative abnormal return (CAR) of a firm's stock onto *Speed Capability* interacted with dummy variables indicating entry during the early pre-2001 regime or late post-2000 regime as well as facility type (gasification versus liquefaction). We use a three-day event window [-1,1]. Firm effects and industry effects are included in the regressions.

not raise CAR in the early regime (a positive but insignificant coefficient on *Speed Capability* × *LNG|EarlyEntry*), but does so very significantly at the 5 percent level in the late regime where uncertainties are better resolved. Again, we suspect that these results are driven only by usage-specific (gasification) entries.

Therefore, we further partition entry timing by facility type in the regressions in Column II, where we introduce interaction between our intrinsic speed measure with dummies indicating early and late entry with gasification and liquefaction facilities. Thus, the coefficients on *Speed Capability x GAS|EarlyEntry* and *Speed Capability x GAS|LateEntry* represent the effect of intrinsic speed capabilities on estimated subsequent performance for early and late entry with gasification facilities, respectively; similarly, the coefficient on *Speed Capability x LIQ|EarlyEntry* and *Speed Capability x LIQ|LateEntry* represent the effect of intrinsic speed capabilities on estimated subsequent performance for early and late entry with liquefaction facilities, respectively. We find that intrinsic speed capabilities is associated with performance enhancement only with late entry with gasification facilities (which have high usage specificity): the estimated coefficients for *Speed Capability x GAS|EarlyEntry*, *Speed Capability x LIQ|EarlyEntry*, and *Speed Capability x LIQ|LateEntry* were insignificant (although positive), whereas the coefficient on *Speed Capability x GAS|LateEntry* is positive and strongly significant and has the greatest magnitude. The coefficient implies a marginal impact on predicted performance to the extent of $112.6 million for a two-month faster firm. These results suggest that the performance benefits from speed occur in the settings where investments require high commitment levels and when intrinsically faster firms choose to enter after uncertainty is better resolved.

## Robustness checks

We conducted multiple robustness checks. We first examined firm-level empirical issues that could have contributed to important missing variable problems in our entry timing and entry performance regressions: (1) we incorporated institutional blockholdings as a control for potential suboptimal managerial behavior, and we obtained very similar estimates; (2) internal firm dynamics and quality matter. Growing firms may be late starters and yet invest at a fast speed. Thus, we need to control for firm differences in growth rates to mitigate the possibility that our results are spurious. We included the four-year compound annual growth rate of total assets and obtained comparable results in our robustness check regressions. We also included measures of firm cash flow (net income before extraordinary items plus depreciation and amortization) and ROA (firm cash flow/total assets) to control for time variant changes in financial performance or firm capabilities that might be omitted from our analysis. With both measures, our results remain robust. (3) We incorporated *R&D Intensity* to control for any influence of technological capabilities on entry timing, and our results continued to support our hypotheses.

We then examined nonmarket environmental issues. A large literature has argued that several institutional features can hinder new venture creation and impair investment (for a review, see Morck, Wolfenzon, and Yeung, 2005; Fogel *et al.*, 2006). These studies suggest that more extractive governments and more bureaucratic environments may make it harder for intrinsically faster firms to gain entry performance advantages with late entry. Note that we include location dummies in estimating the systematic component of 'speed' (Equation 4), implying that our intrinsic speed measure by construction is uncorrelated with the location institutional environment. To further check the robustness of our results, we introduce a proxy for differences in political risk in a location's institution environment since it should capture a multitude of institutional factors that impact on business decisions and slow down fast firms. We used the POLCON measure by Henisz (2000), which measures the political constraints for each country: higher values imply more constraints on the government and, thus, less political risk. While including POLCON as an additional control, our event study results did not change substantially.

Next, we focused on statistical issues in our regressions. We first identified outliers in our entry timing analysis using an index plot of standardized residuals, and we obtained similar results with a sample excluding these outliers. We also included year effects to avoid the collinearity issues with the investment lumpiness and capacity utilization variables, and we obtained logit estimates of similar magnitude and significance as our main results.[11] Similar checks regarding outliers and year effects reveal that our performance regression results in Table 3 remain intact.

We also tried different regime cut-off dates. We used the end of 2000 as the regime division based on industry reports (Weems and Rogers, 2007). For robustness checks, we used the years 1999 and 2001 as alternative cut-off dates between regimes since practitioners' perceived timing for regime change may be less clear-cut. Using 1999, our results for entry timing and entry performance stayed consistent with our broad results. Using 2001, our results for entry timing did not continue to be robust while our results for entry performance stay consistent albeit at lower significance levels. We believe this result may be due to intrinsically faster firms entering right after uncertainty reduction after the winter of 2000.

[11] Gasification entry decisions may also be affected by forecasts of future liquefaction capacity coming on line at the time of completion of entry. Since these expectations are determined by projections in industry trade publications and project announcements each year, year effects should account for these anticipation factors.



DOI: 10.1002/smj

An additional issue related to our choice of regime designation is the possibility of firm differences in LNG market outlook. Our designation is based on marketwide consensus. However, individual firm differences in outlook on the LNG industry can affect their entry decisions. This factor should make it less likely for us to find that firms with higher intrinsic speed capabilities are more likely to enter after a market consensus on the viability of the LNG market has emerged. In addition, our controls in the entry regressions like oil and gas production and capacity utilization should be related to individual firms' market expectations. Finally, one concern is that a firm with more positive outlook for LNG demands may hasten its speed in constructing LNG facilities. If the outlook affects a firm's entry decision, we have an endogeneity problem. We use an instrumental variable precisely for the purpose of avoiding such endogeneity—our proxy for intrinsic speed is based on the deviations of observed project development speed from systematic components in the construction of facilities separate from the liquefied natural gas subindustry.

We also conduct robustness checks regarding the end date of our sample. To account for the possibility that the last years in our sample may be less relevant for entry timing, we reran our results while omitting a later portion of the post-2000 regime data. While omitting years progressively (stopping at 2005, then 2004, then 2003), we obtained results consistent with our main results.[12]

We checked whether our results are affected by alternative econometric specifications. We reran the entry decision regressions using a random effects probit rather than logit with clustered standard errors. Our results using *GAS|Entry* stayed robust while the less refined results using *LNG|Entry* lost significance. This robustness check reinforces the importance of high levels of commitment for our predictions. Additionally, we reran our entry decision regressions where we measure entry as a count of entry investments per firm for each year. Using a negative binomial specification with either standard errors robust to clustering by firm or firm fixed effects, we obtained results similar to our main results.

As further robustness checks regarding our specification for the event study, we considered running OLS with random effects, but eliminated the possibility with a Hausman statistic ($\chi^2 = 5.40$, $p = 0.020$). We did rerun the event study after keeping only firms with more than two (then three) observations to see if the inclusion of firms with limited temporal variation might affect our results. Our results stayed robust across these alternative samples. We also reran our results using various iterations of one-, two-, and five-day events windows, but we did not find the same level of significance as with the three-day window. We suspect this result may be due to the international nature of the news sources used in our announcement data as well as after-hours announcements.

## DISCUSSION AND CONCLUSIONS

We advance the idea that a firm's intrinsic speed capabilities affect its entry timing decision in grabbing a new market opportunity and its subsequent financial performance. Speed capabilities refer to the intrinsic ability to implement an investment project fast. Compared to slow firms, speedy firms can afford to delay entry to wait for information revelation when entry investment is irreversible or usage specific. The strategic flexibility associated with waiting to invest gives speedy firms stronger entry performance. Using firm-level entry data from the Atlantic Basin LNG market, we find support for these ideas. These results were supported while controlling for firm size, levels of diversification, related experience, industry specialized complementary assets, market share, market demand, capacity utilization, investment lumpiness, and rival entry. They also withstand extensive robustness checks.

This article has several implications for both management scholars and practitioners. First, it makes contributions to strategy research focused on firm capabilities and entry timing. Our results show that intrinsic speed capability is a source of competitive advantage in market entry decisions when usage-specific investment is involved, as speedy firms can wait for information revelation.

[12] With the shortened sample sizes in the later period, we adjusted our estimation. For the logit results, we omitted time invariant variables and obtained similar results. For the event study, we enlarged the sample for our fixed effects estimation to include all LNG projects worldwide with interaction terms for speed in the Atlantic Basin, the Pacific Basin, and the Middle East. The results were consistent with our main results (although our event study results are significant at the 10 percent level only when the later regime ends at 2003).



DOI: 10.1002/smj

Our results confirm that entry timing is endogenous and depends on firms' capabilities—and that these capabilities influence the link between entry timing and firm performance. Our results also clarify that the advantage of a 'fast follower' or 'fast second' strategy (Baldwin and Childs, 1969; Markides and Geroski, 2005) stems from a firm's intrinsic speed capabilities. In our specific case, firms with intrinsic speed capabilities facing usage-specific investment can invest after more market information is revealed and, thus, can make more appropriate investment decisions; their speed capabilities allow them to not fall behind even if they enter late.

Finally, from a managerial perspective, our results illustrate the value of developing firm intrinsic speed capabilities in investment project management. We should note that this capability is not the same as just completing an investment project fast, but pertains to the ability of completing investment projects faster than average at the same cost. Our results suggest that firms with above average managerial talents at coordinating and deploying physical and human resources have a distinct advantage in market entry timing. With intrinsic speed capabilities, managers have more flexibility in entry decisions and can afford to wait for market information before making high commitment investments in uncertain new markets.

## ACKNOWLEDGEMENTS

The authors would like to thank Coeditor Will Mitchell, two anonymous referees, Juan Alcacer, Jay Barney, Luis Cabral, Sea-Jin Chang, Connie Helfat, Anne Marie Knott, Michael Leiblein, and Brian Silverman for their helpful comments. All errors remain our own.

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## APPENDIX I

### BACKGROUND ON THE LNG INDUSTRY

The LNG industry focuses on a method used to move natural gas from producer to consumer when the economics of pipelines are not viable (Tusiani and Shearer, 2007; Chandra, 2006).[13] LNG is a refrigerated form of methane (the predominant chemical composition of natural gas). To create LNG, the LNG exporter has to cool the methane down to approximately −163 degrees Celcius to convert the natural gas to liquid form. When cooled to liquid, LNG shrinks to a fraction of its former volume (1/600th the size), improving the cost efficiency of shipping when export and import markets are far apart or separated by large bodies of water (Tusiani and Shearer, 2007; Chandra, 2006).

LNG project development is organized as a ‘chain’ (Chandra, 2006). Entry into the LNG industry requires the construction of very expensive, specialized facilities and transport vessels that comprise the LNG chain. The LNG chain consists of three components: (1) liquefaction facilities that convert natural gas to liquid in the supply market; (2) LNG tankers that transport the LNG to the end market; and (3) gasification facilities that convert the liquefied natural gas back to its gaseous state (Chandra, 2006).

LNG was initially developed in 1914, when Godfrey Cabot first constructed a functional LNG chain using barges (Tusiani and Shearer, 2007). However, LNG was not pursued on a commercial scale until the 1960s, when a major gas discovery in Algeria led to the first commercial-scale LNG chain that became operational in 1964 with a liquefaction plant at Arzew, Algeria, and receiving terminals in France and in U.K. (Tusiani and Shearer, 2007). During the 1960s and 1970s, liquefaction plants were built in Alaska, Libya, Brunei, Abu Dhabi, and Indonesia and gasification terminals were built in Japan, France, Italy, Belgium, Spain, Taiwan, and Korea.

During the 1980s and early 1990s, however, the growth of LNG followed different trajectories in two different submarkets: the Pacific Basin and the Atlantic Basin. In the Pacific Basin, LNG flourished during this period. Because import markets like Korea, Japan, and Taiwan did not have access to domestic sources of natural gas or pipeline imports, importers (e.g., utilities like Kogas, Osaka Gas, and Tokyo Gas) were eager to embrace LNG in order to reduce their dependence on oil (Tusiani and Shearer, 2007). As a result, these importers were more interested in security of supply and were willing to pay higher prices. This attitude, combined with high economic growth, led to numerous terminals being built in these markets, and Japan and Korea became the leading import markets for LNG. In fact, most project development in the 1980s and early 1990s targeted the import markets of Japan and Korea (Tusiani and Shearer, 2007).

In Atlantic Basin markets during this period, LNG had a harder time establishing itself as a viable energy source. Because countries in the Atlantic Basin had abundant sources of domestic natural gas and sources of pipeline imports, importers in the United States and Europe had many alternatives to LNG. As a result, LNG had a hard time competing with energy alternatives in the Atlantic Basin, and the LNG business grew very slowly (Weems and Rogers, 2007; Tusiani and Shearer, 2007; Energy Information Administration, 2003).

#### Atlantic Basin LNG: An emerging opportunity in the late 1990s

The late 1990s witnessed a rebirth in interest in Atlantic Basin LNG, following market liberalization and price surge. A boom in worldwide LNG construction activity became visible after 1999.

Figure 1 depicts U.S. natural gas prices and construction activity in LNG projects.[14] The graph

[13] Our main sources for the description of the LNG industry come from Tusiani and Shearer (2007), Chandra (2006), Weems and Rogers (2007), the *LNG Observer*, the 2007 LNG World Trade poster produced by the *OGJ* and the Gas Technology Institute, the Energy Information Administration’s 2003 report *The Global Liquefied Natural Gas Market: Status & Outlook*, extensive internet searches, and interviews with industry consultants.

[14] Monthly U.S. natural gas wellhead price data was obtained from the Energy Information Administration of the U.S. Department of Energy. LNG construction activity information comes from our data collection efforts described in the Data section.



DOI: 10.1002/smj

illustrates how construction activity in Atlantic Basin LNG closely follows the entry patterns found in industry evolution studies. Entry occurred from the mid-1990s to 2000 at a very slow rate, and natural gas prices historically had stayed around the $2/MMbtu level. At the time, there was a consensus view in the industry that LNG would not be feasible in the United States unless natural gas prices exceeded $3/MMbtu (Weems and Rogers, 2007).

At the end of 1999 and during 2000, industry observers started to conclude that there was an existing supply-demand imbalance in the U.S. due to slower domestic gas production and a surge in demand from gas powered generation resulting in a long-term gas price above the $3/MMbtu threshold (Weems and Rogers, 2007). This view was reinforced in the winter of 2000 after the visible California energy shortage, and natural gas prices broke the $3/MMbtu level and reached a peak of $10/MMbtu in January 2001 (Tusiani and Shearer, 2007), over five times higher than typical price levels. Following this, the consensus on the feasibility of Atlantic Basin LNG market and entry dramatically accelerates until the end of our sample (with a slight reduction in entry in 2007). (See also Weems and Rogers, 2007; Tusiani and Shearer, 2007; more details also available from the authors upon request).

## Key empirical characteristics

A few key characteristics of the LNG industry illustrate how the empirical context of Atlantic Basin LNG fits our theoretical framework well.

First, there have been strong incentives to delay entry into LNG to benefit from additional industry learning and market information. Project costs have been coming down due to more industry experience in LNG project engineering and economies of scale. Across the LNG chain, facility costs have dropped 30 to 50% from the early 1980s to 2003 (Tusiani and Shearer, 2007). LNG tanker costs have also come down from $280 million in 1995 to $150 to $160 million in 2003 (or $124 to $133 million in 1995 U.S. dollars) (EIA, 2003). Additionally, a large component of the success and profitability of a project in Atlantic Basin LNG is determined by a sufficiently high price of natural gas in the import market to make LNG competitive with alternative sources of natural gas. Thus, from both an operational cost perspective and a price uncertainty perspective, incentives to wait and delay entry have been strong. This trend closely fits our theory regarding the marginal benefit of delay from learning.

Second, the LNG industry has also exhibited increasing costs from preemptive pressures, providing incentives to enter early in LNG. Since 2003, escalating raw material costs and intensified worldwide competition for engineering resources, skilled labor with LNG experience, and key equipment have raised the costs of entry (Tusiani and Shearer, 2007). In fact, costs for liquefaction and gasification terminals have doubled since 2003, and LNG tanker costs have increased as well (Tusiani and Shearer, 2007). As a result, preemptive pressures have increased dramatically in the last few years, illustrating that there have been cost advantages to entering early. This trend also fits our theory regarding the marginal cost of delay from preemption.

Third, entry into LNG requires a large investment of resources and lengthy interval for project development. Each component of the LNG chain is very expensive and requires a long lag for regulatory approvals, engineering, and construction. For instance, liquefaction facilities typically costs more than $1 billion and take up to six years to build, LNG tankers cost more than $150 million and take on average two years to build, and gasification facilities cost at least $500 million to build and take two to three years to build (Tusiani and Shearer, 2007). Thus, with each decision to enter the LNG industry, a potential project requires substantial outlays of money, effort, and coordination from each entrant. As a result, entry into the LNG industry with the construction of one of these components of the LNG chain is not a trivial decision. An entrant must carefully consider the costs and time associated with entry with each new facility. In this context, the ability to wait for uncertainty resolution would be appealing.

Fourth, investments at different levels of an LNG value chain represent different degrees of usage specificity. Entry with a gasification facility represents a very usage-specific commitment to the maturation of a chosen import market. If the target market never becomes economically viable, a built gasification facility in that market has little residual value: the owner may rent the facility for natural gas storage for minimal return or even just mothball the facility. With a liquefaction facility, however, the firm has many more options and a



DOI: 10.1002/smj

greater degree of usage flexibility. Principally, the owner has the ability to divert LNG to sell to other markets outside the Atlantic Basin and still make some money. As a result, the LNG industry represents an excellent context to study the role of usage specificity and usage flexibility in the entry decision.

Fifth, entry into the LNG industry is not constrained by proprietary technology. The technology underlying LNG has been around for many years: the liquefaction of natural gas was proved to be technologically feasible as early as 1914 (Tusiani and Shearer, 2007). The technology itself is very simple: liquefaction plants are essentially large refrigerators, and there is no application of chemical processes to the natural gas beyond pretreatment for impurities. Construction of the giant refrigeration process may require procurement of proprietary heat exchangers, process compressors, and turbine drivers, but all of these components are obtained from vendors or procured by hired contractors (Tusiani and Shearer, 2007). Thus, the LNG industry represents an industry with a level technological playing field.

## APPENDIX II

### DESCRIPTION OF INDEPENDENT VARIABLES

| Independent Variables | Definition | Data Source |
|---|---|---|
| Speed Capability | Estimated speed capabilities from (4) | *Oil & Gas Journal* |
| Firm Size | Log of average total sales (1996-2007, deflated to 1996 U.S. dollars) | Compustat, Orbis, OGJ 100/OGJ 200, Annual Reports |
| Age | Number of years since firm founding, standardized | Compustat, Orbis, Web Searches |
| Age$^2$ | Number of years since firm founding, standardized and squared | Compustat, Orbis, Web Searches |
| LNG Tankers | Number of LNG tankers owned by firm | LNG Observer, EIA |
| Oil & Gas Production | Log of Average Oil and Gas Production (1996-2007) in MMboe | OGJ100/OGJ200 |
| Oil & Gas Reserves | Log of Average Oil and Gas Reserves (1996-2007) in MMboe | OGJ100/OGJ200 |
| LNG Experience | Number of LNG investments made by the firm prior to the current year | *Oil & Gas Journal*, LNG Observer, Web Searches |
| LNG Import Market Share | (Firm share of world LNG gasification capacity / total world LNG gasification capacity) * 100 | *Oil & Gas Journal*, LNG Observer, LNG World Trade Map, EIA |
| LNG Export Market Share | (Firm share of world LNG liquefaction capacity / total world LNG liquefaction capacity) * 100 | *Oil & Gas Journal*, LNG Observer, LNG World Trade Map, EIA |
| LNG Demand | Four-year historical compound annual growth rate of world LNG production and regasification | *Oil & Gas Journal*, LNG Observer, LNG World Trade Map, EIA |
| Capacity Utilization | (Average of one- and two-year lags of world LNG trade volume / world LNG facility capacity) * 100 | *Oil & Gas Journal*, LNG Observer, LNG World Trade Map, EIA |
| Investment Lumpiness | (1 / number of operational world LNG facilities) * 100 | *Oil & Gas Journal*, LNG Observer, LNG World Trade Map, EIA |