

ARTIFICIAL INTELLIGENCE SOFTWARE AND ITS IMPLICATIONS FOR FIRMS

by

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ABSTRACT

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The Internet of Things (IoT) industry has been described as the third digital revolution, following advances in the traditional Internet and mobile Internet channels. One of the most widely adopted IoT innovations is the smart speaker (e.g., Amazon Echo, Google Home), which provides users with access to voice assistants (e.g., Amazon Alexa, Google Assistant). Voice assistants employ Artificial Intelligence (AI) software to have natural-language voice interaction with users and can perform a variety of tasks such as setting an alarm or timer, playing music, and controlling other smart objects. With the goal of expanding both the quantity and types of tasks available, Amazon and Google allow independent developers to create their own AI software (e.g., Amazon Skills, Google Actions) to provide more value to users. Many firms have begun to develop this software; for example, Whirlpool allows users to start a load of laundry on their washing machines, Chipotle allows customers to re-order their favorite meals, and Pandora allows users to search for and play music, by simply issuing hands-free voice commands to their smart speakers. While such software clearly provides benefits to consumers, no research has evaluated the potential value perceived by investors. As investors' evaluations of firms consider the expected revenue and costs involved in designing, creating, and marketing innovations such as smart speaker AI, this dissertation adopts the event study methodology to examine investor response as

manifested through stock market behavior. It aims to uncover the overall impact that smart speaker AI has had on firm value, and whether certain AI-, firm-, or industry-specific characteristics moderate this impact in a positive or negative way.

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Introduction

With more than 27 billion objects connected to the internet, about 21% of households worldwide are expected to own Internet of Things (IoT) devices by 2025 (Statista 2020). The IoT industry has been described as the third digital revolution, with the internet and mobile industries being first and second (Novak and Hoffman 2019). Of all the IoT devices, perhaps the most widely adopted one is the smart speaker (e.g., Amazon Echo, Google Home), with 55% of U.S. households expected to own one by 2022 (Braiker 2018). The radically innovative feature of smart speakers is the built-in voice assistant, such as Amazon Alexa and Google Assistant, which permits natural-language voice interactions between users and smart speakers. Voice assistants allow users to verbally issue intuitive commands to perform a variety of tasks, such as setting an alarm or timer, playing music, and controlling other Wi-Fi-connected smart objects. The artificial intelligence (AI)-based software (Davenport et al. 2020) that runs voice assistants can even anticipate users' requests through "hunches" and ask appropriate questions (Priest 2020); the verbal interaction mimics real-time conversations. According to Vijay Sankaran, Chief Information Officer, TD Ameritrade, *"Voice-enabled technology is the future, and with the rollout of support for the Google Assistant, we've added another major piece in our reach across the voice technology ecosystem. Now, nearly any client, on nearly any smart device, has the ability to connect with us seamlessly in a way that feels natural to their lifestyle and doesn't ask them to leave their current platform or routine."*

Most manufacturers of voice assistants allow other firms to create software related to their products and services that add new capabilities to voice assistants. Amazon and Google refer to such software as Skills and Actions, respectively, which I hereafter refer to as voice assistant

functions (or VAFs in short). VAFs expand the capabilities of voice assistants which have the net effect of consumers becoming more efficient, connected, and informed (Ratchford and Ratchford 2021). For example, users can express a verbal command to start a load of laundry with the Whirlpool VAF, apply for a job using the McDonald's VAF, and reorder their favorite meals with the Chipotle VAF. According to Liz VerSchure, Vice President, General Electric, *"Everyone's busy these days and our consumers are looking for simpler and more convenient ways to control their home, especially when busy in the kitchen or working around the house. Integrating our full suite of connected appliances with the Google Assistant makes it easier for owners to control their appliances and get on with their day."* Therefore, VAFs increase the value of voice assistants and their likely adoption and usage by users.

IoT technology is quite new, so research in this emerging area is just starting (see Table 1). A few studies have examined smart speakers and other smart objects and uncovered interesting findings. For example, Kowalczyk (2018) found that perceived ease of use, usefulness, system quality and diversity, enjoyment, technology optimism, and risk have a strong impact on consumers' intention to use smart speakers. Mulcahy et al. (2019) analyzed how general perceptions regarding technology affect opinions and imagined experiences with smart home technology, which in turn impact consumers' adoption intention. Through semi-structured interviews, Foehr and Germelmann (2020) learned how smart speaker users build and maintain trust in their devices. The extant research has focused on (1) the consumer perspective and (2) IoT technologies at a broad, general level. No research has specifically studied VAFs and the voice-activated technology. Addressing this research gap is important, as VAFs can have immense strategic implications for firms, a fact that a growing body of research has begun to address (Davenport et al. 2020; Grewal et al. 2020; Guha et al. 2021). For instance, an interesting research

Table 1: Relevant Internet of Things (IoT) Literature

Paper	Area of Focus	Contribution
Shankar (2018)	Artificial Intelligence (AI)	Discusses how AI can be leveraged by retailers to provide benefits on the supply and demand side, and draws attention to future AI developments that may warrant further examination
Kowalczyk (2018)	Smart speakers	Analyzes customer review data and assesses which types of perceptual dimensions (e.g., ease of use, usefulness) affect consumer acceptance (use intention) of smart speakers
Mulcahy et al. (2019)	Smart objects	Analyzes survey data to assess the intertwined relationships between consumers' technology readiness, engagement, perceived risk and trust, and adoption intention
Foehr and Germelmann (2020)	Smart speakers	Conducts qualitative studies to understand how trust is developed as consumers interact with smart speakers
Davenport et al. (2020)	Artificial Intelligence (AI)	Proposes a multidimensional framework to understand the impact of AI based on intelligence levels, task types, and whether AI is embedded in a robot, with implications for customer behavior and firms' marketing strategies
Guha et al. (2021)	Artificial Intelligence (AI)	Proposes a framework for how retailing firms' managers should think about adopting AI, based on interview data which reveals customer-facing and non-customer-facing AI applications
My dissertation (2022)	Smart speakers' voice assistant functions (VAFs)	Analyzes whether firms have gained financial value from developing and announcing voice assistant functions, and which factors (capability type, firm type) have a moderating impact

question can be, what is the value of a VAF? This research provides a partial answer to this question by studying one specific benefit that firms may obtain from the launch of a VAF - higher stock market valuation by investors. I apply the event study methodology to examine the impact of VAF announcements on the stock market returns of publicly traded firms that announced a VAF between 2016 and 2020. I further identify key VAF- and firm-related characteristics that moderate the impact of a firm's VAF announcement on firm value. This study follows a long tradition of examining the effect of channel additions, such as internet websites and mobile apps, on firm value.

My work makes three primary contributions to the marketing literature. First, I adopt a supply- and demand-side framework to theorize how investors perceive VAF announcements and their impact on firm outcomes. Complementing Shankar (2018) that recognizes the supply- and demand-side benefits that artificial intelligence technologies can produce, I empirically verify whether investors recognize these benefits or not. Similar to Geyskens et al. (2002) and Cao et al. (2018), who applied the supply- and demand-side framework to understand investors' response to internet and mobile channel announcements, respectively, I find that the effect of a VAF announcement on firm value is positive – a .32% increase on average. From a theoretical perspective, this suggests that investors believe VAFs produce benefits for firms with respect to both supply (e.g., greater economies of scale and cost efficiencies) and demand (e.g., providing value to existing and new customers).

Second, I extend Novak and Hoffman's (2019) research by theorizing how VAFs may impact the assemblage in which consumers and smart speakers interact. As VAFs are designed with different types of capabilities and by different types of firms, I propose that these factors may enable (i.e., positively impact) or constrain (i.e., negatively impact) consumers' experiences,

which may lead investors to reward (or penalize) firms to different extents. My empirical analysis confirms that the impact of a VAF announcement on firm value is moderated by these factors. I find VAFs that include informational capabilities (e.g., news briefings, information search) are more positively received by investors than VAFs that do not, likely due to the fact that such capabilities allow users to self-extend parts of their identity and, in turn, self-expand as they absorb and trust the content provided to them. Next, I learn that VAFs that include object-control capabilities (e.g., change the channel on a smart TV, preheat a smart oven) are not received any differently by investors than VAFs that do not, in light of the fact that such capabilities typically limit consumers' ability to use the smart objects they own to their fullest extent. In addition, I discover that VAFs that include transactional capabilities (e.g., pay a bill, make a purchase) are received negatively by investors, compared to the ones that avoid such capabilities, as consumers are typically restricted to repurchasing a product they already bought (rather than being able to purchase new things). Consumers must also have a pre-existing relationship (e.g., existing account) with firms to use other forms of transactional capabilities, thereby limiting the ability of firms to attract new customers. Finally, I find that firm type (firms that primarily sell products versus services) leads to differential effects, such that product firms witness a larger positive effect from announcing a VAF than service firms. This may be because, while VAFs of product firms allow them to add a new dimension to the physical nature of their products, VAFs of service firms provide services similar to what is available through their existing channels and therefore do not enhance consumers' experience.

Third, since my research is the first of its kind to specifically analyze VAFs, I propose several important directions that warrant much-needed research within this domain. Such research could help scholars and managers understand the implications of VAF technology further, to

prepare for a channel that will likely undergo significant changes in the coming years. It will be extremely important for firms to get ahead of this curve, as recent research suggests that the digital landscape is rapidly evolving, with 80% of digital business transformations resulting in losses or no incremental benefit to firms (Wielgos et al. 2021).

In the following sections, I outline the conceptual framework driving my hypotheses, explain the event study methodology and my data collection process, review the results of the event study and moderation analysis, and conclude with a discussion of important managerial implications and directions for future research.

Conceptual Framework

The Value of Voice Assistant Functions (VAFs)

To understand how a VAF might affect firm value, I review prior literature in the area of channel additions (Geyskens et al. 2002; Homburg et al. 2014; Cao et al. 2018) to identify different factors on the supply (firm) and demand (customer) sides that might influence investors' perceptions.

On the supply side, VAFs may allow firms to achieve greater economies of scale by reducing their costs across a larger base of customers (Poppo and Zenger 1998). For example, physical distribution costs may be reduced, as VAFs allow voice assistants to communicate directly with users and automatically link them to firms' technological infrastructures, thereby reducing paperwork, employee errors, and customer disputes (Geyskens et al. 2002). In addition, as firms' software developers program and control VAFs with a predetermined set of computerized code, a variety of transaction costs, such as monitoring (Dyer 1997) and safeguarding costs (Klein and Leffler 1981), may be reduced since operational efficiency is attained through automation (Sorescu et al. 2011).

On the demand side, VAFs allow firms to provide value to existing and new customers (Kim et al. 2015), factors that are essential contributors to firm value (Gupta 2013). Existing research has found that users' enjoyment of smart speakers, in addition to the quality and number of features incorporated, has a positive effect on their adoption (Kowalczyk 2018), suggesting that firms' VAFs may be able to enhance adoption by introducing new features. In addition, Lee and Cho (2020) found that many consumers use smart speakers due to perceptions of the existence of a social relationship, which is aided and fostered by direct vocal feedback from smart speakers in response to users' voice commands, providing the feeling of socializing or having a conversation. Therefore, through their VAFs, firms may be able to provide novel value by establishing meaningful social connections with consumers.

Considering the supply-side and demand-side benefits of VAFs, I expect many firms to use announcements of VAFs to not only signal to the market that they have a strategic interest in engaging with consumers through a new, innovative medium (Boyd et al. 2019), but also reduce investors' informational asymmetry with regards to future cash flow (Kumar and Shah 2009). As investors collect new information surrounding firms and their activities, they update their expectations through their stock market reactions (i.e., buying or selling stock), which dictates firm value (Raassens et al. 2012). Accordingly, I posit the following:

***H1:** A VAF announcement by a firm has a positive impact on the firm's value.*

My discussion to this point has focused on the direct, main effect of VAF announcements on firm value. Investors typically investigate additional cues from such announcements to form a more accurate estimate of the potential benefits to firms, which can lead certain firms to witness more positive financial effects than others (Bhagwat et al. 2020). Since VAFs are specifically

designed by firms to provide new forms of value to consumers who own smart speakers, I refer to assemblage theory to theoretically understand how consumers' experience may be influenced (i.e., enabled or constrained) by VAFs.

Assemblage Theory

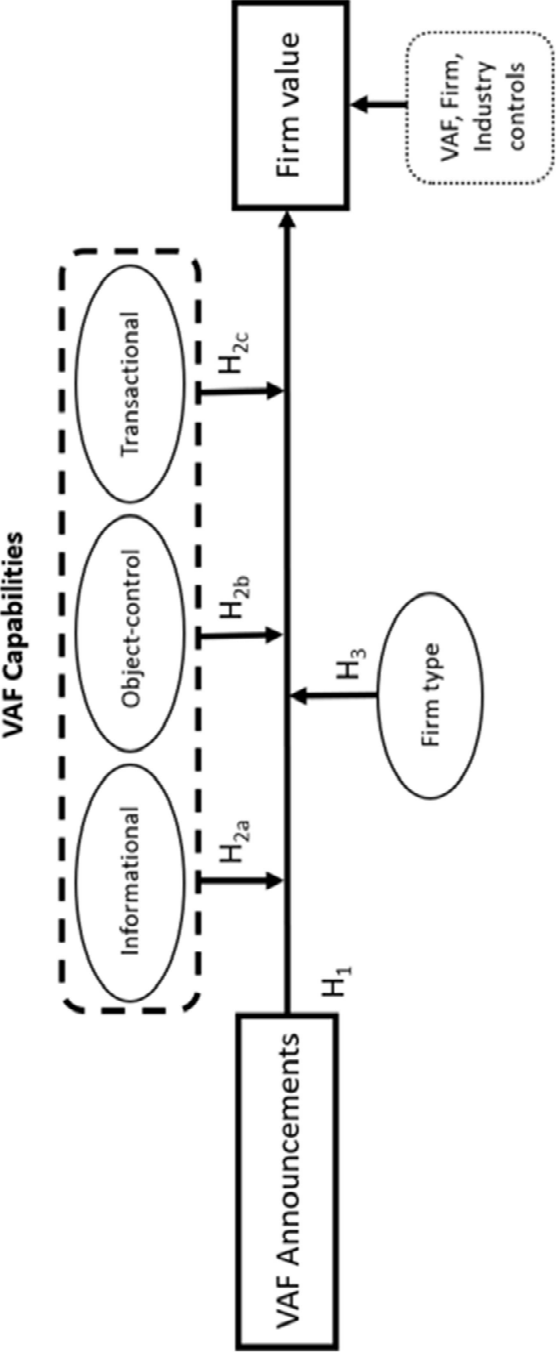
As consumers (i.e., human actors) interact with smart speakers (i.e., nonhuman actors), an assemblage emerges that is defined by the properties and capacities that arise from the interactions among its component parts (Hoffman and Novak 2018). Consumers and smart speakers express both agentic roles since they can each affect the assemblage, and communal roles since they can each be affected *by* the assemblage. These expressive roles, in turn, define the experience of the consumer, which can be positive or negative. Positive experiences result when the consumer enables (or is enabled by) the assemblage. For example, self-extension experiences (Belk 1988; Belk 2013) occur when the consumer extends part of their identity into the assemblage; self-expansion experiences (Aron et al. 1991) occur when the consumer absorbs aspects of the identity of the assemblage into themselves (Novak and Hoffman 2019). On the other hand, negative experiences result when the consumer constrains (or is constrained by) the assemblage. For example, self-restriction experiences occur when the consumer limits what the assemblage can do, and self-reduction experiences occur when the consumer is limited by what the assemblage does (Novak and Hoffman 2019).

By developing VAFs and allowing consumers to download them, firms affect the aforementioned assemblage by modifying smart speakers and what they are able to do. VAFs add a variety of new types of functional capabilities that consumers can utilize, which subsequently affect consumers' experience and relationship with brands (Keller 2012). The assemblage that

results from the modified smart speakers may implicitly enable or constrain consumers' experience (DeLanda 2016), which, as discussed earlier, can have positive or negative effects and which, in turn, may be rewarded or penalized by investors. In the following sections, I extend the work of Boyd et al. (2019) to the voice channel context and theorize how different types of VAF capabilities have different implications for consumers' experience. Firms are able to include informational, object-control, and transactional capabilities in their VAFs (see Table 2 for examples) and can even include multiple types of capabilities if desired. Understanding the implications of each type of capability is important, as investors may reward (or penalize) firms in different ways. In addition, I extend the work of Cao et al. (2018) to the current context and theorize how firm type (product versus service firms) may moderate the impact of a VAF announcement on firm value. My full conceptual model is provided in Figure 1.

Informational capabilities provide consumers with novel ways to access various types of information. Firms such as CNN and CNBC have developed VAFs with “flash briefings” that automatically procure the day's top news stories and read them aloud to consumers – all following a simple command such as “What's the latest news?” or “How are the markets doing?” Rather than having to wait for a specific time of day (e.g., evening news reports on TV) or search online and read several news articles one by one, consumers can conveniently have the news procured and presented to them on demand, based upon a brief one-time setup where consumers indicate which news briefings should be included and what should be the order of presentation. In addition, many firms have developed VAFs that make it easy for consumers to search for information. For example, Allrecipes's VAF allows consumers to discover new meal recipes with their voice and reads aloud step-by-step instructions; Clairol's VAF works with consumers to identify their

Figure 1: Conceptual Model



personal hair color treatment plan and provides instructions on the application process; the United Parcel Service (UPS) VAF allows consumers to check the status of their incoming shipments; and WebMD's VAF offers health and personal wellness advice in response to questions such as "What should I eat after my workout?" or "How can I treat my runny nose?" Therefore, consumers can efficiently access the information that they need by asking questions aloud and engaging in a realistic conversation with voice assistants. Since informational capabilities allow consumers to self-extend part of their identity (Hoffman and Novak 2018) by indicating their preferences (e.g., preferred news organizations, favorite cuisines) and sharing personal information (e.g., health concerns, account-related data) with their smart speakers, VAFs that include these capabilities actively incorporate personalized information when responding to consumers and likely have enabling effects on consumers' experience. In addition, as informational capabilities enhance social presence and strengthen the relationship between consumers and their smart speakers, consumers may self-expand as they begin to "treat others' resources, perspectives, and identities as if these were their own" (Aron et al. 1992). I believe that investors may reward firms for including informational capabilities in their VAFs, as consumers' experience may be positively affected. Therefore, I posit:

***H2a:** Informational capabilities included in the VAF announcement by a firm positively moderate the impact of the announcement on firm value.*

Object-control capabilities allow consumers to control other smart objects that are linked wirelessly to smart speakers through Wi-Fi connections. For example, consumers can adjust the temperature of their homes with Honeywell's VAF, which communicates with its smart thermostats; change the channel or volume on their smart DVR with TiVo's VAF; and preheat

Table 2: Voice Assistant Function (VAF) Capability Types and Examples

Capability Type	Operationalization	Announcement Examples
<i>Informational</i>	VAF enables the user to have information procured and presented with minimal effort required, allows the user to ask questions, ask for personal or account-related information	<p>"...you can ask Alexa about any news story CNN is currently covering, like the U.S. elections or other breaking news...for example, say "the latest on the election" or more generally, just "the latest news"</p> <p>"TripIt users can now ask Google Assistant for their flight summary, information about the weather, aircraft and much more"</p> <p>"After linking their Expedia accounts to the Action...travelers can check Expedia Rewards balances"</p>
<i>Object-control</i>	VAF enables the user to control other Wi-Fi-connected smart objects	<p>"If you have DirectTV and you're fed up of having to use an old-fashioned remote to get to the content you want to watch...it's then a matter of using your voice to play, rewind and record shows, or change the channel"</p> <p>"Users can ask (their HP home printer) to print games like sudoku puzzles or bingo cards, their to-do or shopping lists, coloring pages and even graph paper, blank calendars or notebook paper"</p> <p>"Moen is adding Alexa voice control capability; with the new skill, you can tell Alexa to turn on your shower at a desired temperature or to a customized setting"</p>
<i>Transactional</i>	VAF enables the user to make a payment or make a full purchase of a product or service	<p>"Domino's customers with a Pizza Profile can place an order with the Google Assistant...the customer can order their saved Easy Order or recent order, and can also ask Google to track their order progress"</p> <p>"Customers just say 'Alexa, ask 1-800-FLOWERS.COM to order a dozen roses' and (Alexa) will process the order and arrange for delivery"</p> <p>"...you'll be able to buy items from Walmart with your voice through Google Home and then have your purchase delivered to your home"</p>

their smart oven or start, pause, or resume the laundry cycle on their smart washing machine with the Whirlpool VAF. Although object-control capabilities can provide convenience and efficiency benefits, it is important to note that they carry a limited range of features when compared to the physical interfaces of the smart objects they control. For example, Honeywell's VAF does not allow consumers to control the temperatures of different zones within their home (the firm's smart thermostats do), TiVo's VAF does not allow consumers to search for movies and television shows or access recorded content (the firm's smart DVRs do), and Whirlpool's VAF does not allow consumers to use their oven's broil function or change the type of laundry cycle (the firm's smart appliances do). As object-control capabilities limit consumers' ability to use the smart objects they already own to their fullest potential, I believe they may have a constraining effect on consumers' experience. Self-reduction may occur, as consumers "exercise their capacities during interaction with a given assemblage in ways that are 'less than' how those same capacities may be exercised in other contexts" (Hoffman and Novak 2018). This could lead consumers to become less engaged with the object being controlled (Mick and Fournier 1998). As a result, investors may not be receptive to object-control capabilities. Formally, I propose the following:

***H2b:** Object-control capabilities included in the VAF announcement by a firm negatively moderate the impact of the announcement on firm value.*

Transactional capabilities allow consumers to pay a bill, make a purchase, or place an order by voice command. For example, the Avis VAF allows consumers to reserve a rental car, the Starbucks VAF allows consumers to reorder their favorite drink, and the Capital One VAF allows consumers to pay their credit card bill. These capabilities focus on the purchase phase of the consumer journey (Boyd et al. 2019) and may enhance customer spending (Kushwaha and Shankar

2013), reflecting why firms choose to include them in their VAFs. However, assemblage literature suggests that consumers' experience may be constrained by transactional capabilities, as they lock consumers into a repetitive and stagnant assemblage that limits what is possible going forward (Hoffman and Novak 2018). Transactional capabilities constrain consumers to repurchasing products they purchased in the past rather than enabling them to discover and purchase new products. Such limitations constrain the variety-seeking tendencies on the part of the consumer. In addition, while transactional capabilities may provide convenience benefits to existing customers, they alienate consumers who do not have a pre-existing relationship with the firm (e.g., an existing account). Therefore, transactional capabilities have a limited ability to attract new customers, as firms that incorporate these capabilities into their VAFs cannot simply target any smart speaker owner. In summary, I believe investors may penalize firms for including transactional capabilities in their VAFs, as they may lead to a self-reduced consumer experience by emphasizing habitual use (Murray and Haubl 2007) and also inhibiting new customers from enjoying a richer assemblage.

H2c: Transactional capabilities included in the VAF announcement by a firm negatively moderate the impact of the announcement on firm value.

Firm type (product versus service firms) may also affect investors' perceptions of the value of a VAF. In the context of mobile channel addition, Cao et al. (2018) found that firms that primarily sell products (as opposed to services) are rewarded more positively by investors when announcing the release of a mobile app since these firms can leverage their existing assets (e.g., physical inventory, distribution network) to reach consumers more efficiently. In the current context of voice channel additions, assemblage theory suggests that product firms may have a greater

potential to enable consumers' experience than service firms. I believe this to be the case since product firms often use their VAFs to add a new dimension to the physical nature of their products, thereby offering new forms of value that can lead to deeper customer engagement (Grewal et al. 2017). For example, Clairol, which for decades has focused on designing and distributing its various hair-care products, now is able to speak directly to its customers in their own bathrooms, guiding them through their hair-coloring process with a variety of information, which customers previously had to read on small-print instructional packets or search for online. Quaker, whose food products have been well-known American staples for more than 140 years, has capitalized on a growing consumer trend for overnight oatmeal (a preparation method from the 1800s) by developing a VAF that guides customers through the cooking process, allowing the firm to add a new dimension to its relationship with its customers. Service firms such as United Airlines (e.g., ask for flight information and amenities) and American Express (e.g., review recent account charges) have VAFs that often provide services similar to what is available through their online, mobile, and even telephone channels. Therefore, I hypothesize that investors may reward product firms more positively than service firms for their VAFs, as consumers' experience becomes further enabled in ways that were previously not possible. Thus,

H₃: Firm type moderates the impact of a VAF announcement on firm value, such that product firms witness a stronger positive impact than service firms.

Methodology

Data Collection

To study the effect of a VAF announcement on firm value, I searched the Amazon Alexa and Google Assistant VAF marketplaces to compile an inclusive list of all Skills (Amazon's VAFs) and Actions (Google's VAFs) that are offered by publicly traded firms (as opposed to independent, third-party developers). Next, I searched for the earliest public announcement of each VAF by using ProQuest and Lexis-Nexis, a comprehensive database of business news publications. I also searched for online articles and news releases by firms on their respective websites. In total, I found 112 VAF announcements. To eliminate any confounding effects, I removed announcements that were made in close time proximity to announcements related to firms' earnings releases (Borah and Tellis 2014; Sorescu et al. 2017). The final dataset consists of 96 VAF announcements; the sample size is similar to that of many other event studies (e.g., Boyd et al. 2010; Raassens et al. 2012; Gao et al. 2015).

Dependent Variable

Event study methodology is best suited for my research questions, as it provides an accurate measure of the change in a firm's value due to the announcement of its VAF. Financial theory holds that a firm's current stock price reflects the market's expectations regarding the discounted value of all future cash flows that are expected to be accrued by the firm (Rappaport 1987). Therefore, the effect of a firm's VAF announcement on its (firm) value is expected to be captured in an immediate manner by the market through the firm's stock price as soon as the information is made publicly available. Formally, this effect is referred to as abnormal return (AR) and is measured as:

$$AR_{it} = \frac{P_{it} - E(P_{it})}{P_{it-1}} = R_{it} - E(R_{it})$$

P_{it} and P_{it-1} are the actual dividend-adjusted prices of the stock of firm i at time t and $t-1$, respectively, and $E(P_{it})$ is the expected dividend-adjusted price of stock i if the announcement had not been made. R_{it} is the realized rate of return of the stock of firm i at period t , and $E(R_{it})$ is the expected return of stock i at period t that would have been obtained had the event not occurred (Sorescu et al. 2017). To estimate the expected return $E(R_{it})$ of stock i at period t and subsequently abnormal return, I utilize the market-adjusted model (Brown and Warner 1985). This model calculates $E(R_{it})$ as the average rate of return of all stocks that are traded in the stock market at period t and is recommended to be used for short-term event studies such as mine (Sorescu et al. 2017, pp. 195). Expected returns were estimated over a period of 250 trading days, ending 50 days before the event day.

Abnormal return reflects the change in stock price above or below the expected price on a *specific day*. However, since an event's effect on the firm's stock price may persist beyond the event day, abnormal return is often estimated over a measurement window spanning several days by aggregating the abnormal returns for each day within that window. This aggregated value is referred to as cumulative abnormal return (CAR) and mathematically expressed as follows:

$$CAR_{it} = \sum_{t-a}^{t+b} AR_{it}$$

AR_{it} is the abnormal return of stock i on day t (the event day itself), and a and b are the number of days before and after the event day, respectively, which are chosen as the endpoints of the event window. Abnormal returns may also occur before the event due to leakage of information that investors may have received before the announcement (Fama 1970). Event windows can be

as short as the event day itself (Fornell et al. 2006) or as many as five days (Cornwell et al. 2005; Kalaignanam and Bahadir 2013). In practice, CAR is estimated across various windows spanning many days before and after a firm's announcement. Following prior event studies, I selected the window with the most significant t-statistic for subsequent analysis (Sorescu et al. 2017). I obtained all financial data from the Center for Research in Securities Prices (CRSP) database.

Independent Variables

Details regarding the independent variables were collected from the VAF announcements and Compustat. First, the content of the announcements was manually analyzed by two independent, undergraduate student raters to identify values for the variables relating to VAF capability types. I ensured that these raters had no prior knowledge of the VAF announcements or any personal experience using VAFs. I provided the 96 VAF announcements to the raters and instructed them to read each announcement and assign a value of 1 to the informational capabilities variable, if the VAF announcement mentioned such capabilities, and 0 otherwise. The same process was carried out for the object-control and transactional capabilities variables. Inter-rater reliability of the two raters was excellent (informational capabilities $\alpha > 93\%$, object-control capabilities $\alpha > 98\%$, transactional capabilities $\alpha > 96\%$) and any strong uncertainties were discussed. For the fourth independent variable – firm type – I used Compustat to denote whether the firm announcing a VAF primarily sells services (0) or products (1). Cao et al. (2018) used a similar approach. Table 3 summarizes data details.

Table 3: Measurement Variables and Data Sources

Variable	Description	Source
Abnormal stock return (dependent variable)	Difference between actual and expected returns during the event window, as calculated by the market-adjusted model	Center for Research in Security Prices (CRSP)
<u>Moderating Variables</u>		
Informational capabilities	Dummy variable identifying if a VAF includes informational capabilities (1) or not (0)	VAF announcement
Object-control capabilities	Dummy variable identifying if a VAF includes object-control capabilities (1) or not (0)	VAF announcement
Transactional capabilities	Dummy variable identifying if a VAF includes transactional capabilities (1) or not (0)	VAF announcement
Firm Type	Dummy variable for firms primarily selling services (0) or products (1)	Compustat
<u>Control Variables</u>		
Firm size	The natural log of a firm's total assets	Compustat
Time period	Dummy variable identifying whether a VAF was announced between 2016 and 2018 (0) or 2018 and 2020 (1)	VAF announcement
Competitive intensity	Inverse Herfindahl-Hirschman index for industry concentration (industry SIC code)	Compustat
Product demand growth	The percent change in a firm's total industry sales from the previous year's sales (industry SIC code)	Compustat
Industry advertising	The average five-year advertising-to-sales ratio for a firm's industry (industry SIC code)	Compustat
Platform	Dummy variable identifying whether a VAF was announced for Google Assistant (0) or for Amazon Alexa (1)	VAF announcement

Control Variables

Following prior event studies that included additional factors that may influence stock returns, I included several control variables. At the firm level, firm size is calculated as the natural logarithm of a firm's total assets (Sorescu et al. 2017; Cao et al. 2018). Time-period controls for time-related effects, as firms that announced VAFs earlier (as opposed to later) may have been rewarded more positively by investors (Boyd et al. 2019) or less (Geyskens et al. 2002). This variable was developed by arranging the dataset of 96 VAF announcements by announcement date and then splitting the announcements into two equal groups, following the approach taken by Boyd et al. (2019). Time period is measured as 0 for VAFs announced between 2016 (January) and 2017 (December), and 1 for those announced between 2018 (January) and 2020 (January).

At the industry level, competitive intensity represents the inverse Herfindahl-Hirschman index for industry concentration (Homburg et al. 2014), which accounts for the number of competitors within a firm's industry and their respective market shares. Product demand growth is assessed as the percent change in industry sales from the previous year's sales (Geyskens et al. 2002). Industry advertising is evaluated as the average five-year advertising-to-sales ratio within a firm's industry (Boyd et al. 2010). Finally, I include a VAF-level dummy variable, Platform, which controls for potential effects relating to platform popularity, as investors may reward VAFs announced for Google Assistant (0) or Amazon Alexa (1) differentially. Full information regarding variable measurement and sources is provided in Table 3. Correlations and descriptive statistics of all variables are presented in Table 4.

Table 4: Correlations and Descriptive Statistics

	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10
1. Informational capabilities	.80	.40	1									
2. Object-control capabilities	.24	.43	-.27**	1								
3. Transactional capabilities	.22	.42	.19	-.23*	1							
4. Firm type	.39	.49	-.39**	.44**	.03	1						
5. Firm size	10.43	1.93	.10	.02	.01	.05	1					
6. Time period	.50	.50	-.07	.02	-.12	-.08	-.02	1				
7. Competitive intensity	6.82	5.77	.16	-.15	.08	-.22*	.27**	-.01	1			
8. Product demand growth	0.03	.12	-.02	-.13	.28**	-.10	-.02	.06	.12	1		
9. Industry advertising	.02	.02	.20*	-.27**	.10	-.14	-.09	.16	-.13	.26**	1	
10. P/platform	.73	.45	-.06	-.09	-.07	-.08	.05	-.14	.01	-.08	-.03	1

Note: *p-value < .05, **p-value < .01

Selection Bias Correction

As systematic differences may exist between firms that decide to announce a VAF and those that do not, potential selection bias may confound model estimation results. The decision to announce a VAF may be the outcome of unobserved factors that may affect the abnormal return for a firm. Therefore, following prior event studies in marketing (see Sorescu et al. 2017 for examples), I adopt the two-stage Heckman procedure (Heckman 1979) to control for these potentially confounding effects. In the first stage, I use a probit model to estimate a firm's propensity to announce a VAF based on specific firm characteristics. I began by collecting a matched sample of firms that have not announced a VAF but are similar in size ($\pm 25\%$; Fang et al. 2015; Cao et al. 2018; Ertekin et al. 2018) to those in my sample and are within the same industry (SIC code). To allow for model identification, I used several variables as instruments within the first stage that are excluded from the second stage. First, I included a dummy variable that takes on a value of 1 if a firm has released a mobile app and 0 otherwise. Since developing a mobile app reflects a high level of knowledge and experience in the realm of channel additions, this likely has an impact on whether a firm has enough of an innovative technological background to approach the voice channel. Next, following Bhagwat et al. (2020), I included several firm-specific financial characteristics (return on assets, leverage, book-to-market ratio, sales growth) since performance may affect whether firms are able to justify adoption of the voice channel, as it may pose uncertainty to investors.

After the first-stage model was estimated, its coefficient estimates were used to calculate the inverse Mills ratio, which takes the form of an additional regressor in the second-stage model to control for potential selection bias. The following second-stage model includes this component,

in addition to the hypothesized regressors and control variables, to assess their impact on the abnormal stock return that firm i witnesses from announcing VAF j :

$$\text{CAR}_i = \beta_0 + \beta_1 \text{Informational}_{j,i} + \beta_2 \text{Objectcontrol}_{j,i} + \beta_3 \text{Transactional}_{j,i} + \beta_4 \text{Firmtype}_i + \beta_{5-10} \text{Controls}_i + \beta_{11} \text{Inversemills}_i + \varepsilon_i \quad (1)$$

Results

Table 5 shows the results of the first-stage probit selection model ($\chi^2 = 35.86$, $p < .01$). Two instrumental variables were found to be significant: mobile app release ($p < .01$) and return on assets ($p < .01$). The model is properly identified and allows us to calculate the inverse Mills ratio, which I include in the second-stage model. To ensure that the exclusion restriction of the Heckman procedure is met, I assessed whether the inverse Mills ratio is significantly correlated with any of the independent variables in the second-stage model (Certo et al. 2016; Bhagwat et al. 2020). All correlations are less than .07 and insignificant (each $p > .49$), therefore allowing us to proceed with the results of the second-stage model.

Main Effect of a VAF Announcement on Firm Value

I ran several alternative models, and the results of these analyses are reported in Table 6. Model 1 has VAF-specific variables and control variables, Model 2 has firm type and control variables, Model 3 has all the moderating variables but no control variables, and Model 4 is the full model with all variables. No intolerable multicollinearity was found among the variables, as all variance inflation factors were below 2. The full model has the highest adjusted R-square and, therefore,

Table 5: Heckman First-Stage Probit Selection Model Results

Variable	Estimate	Chi-Square
Intercept	-1.771	5.246**
Mobile app	1.330	7.672***
Firm size	.028	.279
ROA	7.506	7.348***
Leverage	.414	.283
Book-to-market	-0.059	.083
Sales growth	.139	.055

Model Chi-Square: 35.86***

Note: *p-value < .10, **p-value < .05, ***p-value < .01

the rest of the discussion is limited to the full model (Model 4). The F-statistic of Model 4 is also statistically significant and rejects the null hypothesis that all regression coefficients are zero.

The main effect of a VAF announcement on firm value ($t = 2.2, p < .03$) is found to be significant. This supports H_1 . In line with the most statistically significant event window (Sorescu et al. 2017), the effect begins four days before the event day $(-4,0)$ and the average firm witnesses a .32% increase in firm value from announcing a VAF. The magnitude of this positive effect is similar to that of the effect estimated after the announcement of a mobile app (0.30% in Cao et al. 2018; 0.37% in Boyd et al. 2019), but is lower than that reported after the announcement of an internet channel addition (0.71% in Geyskens et al. 2002). Multiplying the CAR by the average market value of firms in my dataset suggests that \$296 million in firm value is created on average when a firm announces a VAF. Next, I review my analysis of moderating factors to evaluate H_{2a-c} and H_3 , and to identify the factors that affect the gain in firm value from a VAF announcement.

Analysis of Moderating Variables

To assess the moderating effects of the hypothesized variables on the impact of a VAF announcement on firm value, I estimated Equation 1. This included the inverse Mills ratio, which was found to be statistically insignificant ($p > .38$), thereby revealing no selection bias.

In support of H_{2a} , the mention of informational capabilities in a firm's VAF announcement is found to positively moderate the impact of the announcement on firm value ($t = 2.41, p < .02$), suggesting that investors reward firms that release VAFs that provide easy access to information. H_{2b} is not supported, as the mention of object-control capabilities in a firm's VAF announcement is found to have an insignificant moderating impact ($t = -1.2, p > .23$). Next, support for H_{2c} is found, as the mention of transactional capabilities in a firm's VAF announcement is found to have

Table 6: Model Results

Variable	Model 1	Model 2	Model 3	Model 4
	Estimate(SE)	Estimate(SE)	Estimate(SE)	Estimate(SE)
Intercept	.022** (.008)	.023*** (.008)	.001 (.004)	.022*** (.008)
Informational capabilities	.005 (.003)	---	.007* (.004)	.010** (.004)
Object-control capabilities	-.001 (.003)	---	-.004 (.003)	-.004 (.003)
Transactional capabilities	-.009** (.003)	---	-.010*** (.003)	-.012*** (.003)
Firm type	---	.001 (.001)	.003** (.001)	.004** (.001)
Firm size	-.001** (.000)	-.001** (.000)	---	-.002*** (.000)
Time period	-.000 (.003)	.000 (.003)	---	.000 (.002)
Competitive intensity	-.000 (.000)	.000 (.000)	---	.000 (.000)
Product demand growth	.009 (.015)	-.001 (.014)	---	.014 (.014)
Industry advertising	-.040 (.108)	.015 (.106)	---	-.052 (.105)
Platform	-.000 (.001)	.000 (.001)	---	.000 (.001)
Inverse Mills	-.000 (.000)	-.000 (.000)	---	-.000 (.000)
F-statistic	1.48	1.03	2.63	2.06
R-squared (adjusted R-squared)	.148 (.048)	.086 (.002)	.103 (.064)	.212 (.109)
Observations	96	96	96	96

Note: *p-value < .10, **p-value < .05, ***p-value < .01. The numbers in brackets are standard errors

a significantly negative moderating impact on firm value ($t = -3.16, p < .01$), suggesting that investors penalize firms that release VAFs that provide payment or repurchase abilities. Finally, in evaluation of H₃, support is found, as firm type is significant ($t = 2.61, p < .01$), revealing that VAF announcements made by product firms are rewarded more positively than those of service firms.

Robustness Checks

I checked the robustness of my results in three ways. First, I employed several alternative asset pricing models that have been used in past finance and marketing event studies (Sorescu et al. 2017): the market model (Brown and Warner 1985), Fama-French three-factor model (Fama and French 1993), and Carhart's four-factor model (Carhart 1997). Thereafter, I repeated my event study and re-estimated Equation 1 for each of the models. In summary, I was able to substantiate the results of the main study with no notable differences with regards to my hypotheses. The Carhart four-factor model was found to have the highest adjusted R-square amongst the three alternative models but was still less than the market-adjusted model that was used in the main study. In the second robustness test, I wanted to ensure that outliers did not influence my results; I performed a 90% winsorization of the data, which caps observations below the 5th percentile and above the 95th percentile at a fixed level (Boyd et al. 2019; Wies et al. 2019). I then re-estimated the main model and the three alternative asset-pricing models and found that all hypotheses continue to be supported. Finally, since emerging research has suggested that user enjoyment has a strong impact on smart speaker usage intention (Cha et al. 2021), I included an additional moderating variable in my main study to test whether the mention of hedonic capabilities in a firm's VAF announcement has an impact on investors' reactions. Hedonic capabilities included

in VAFs typically focus on user entertainment. For example, the Jeopardy VAF quizzes users on a wide range of subjects, the Huggies VAF provides music and games to children, and the Wild 'N Out VAF allows users to freestyle rap following a short set of lyrics. After re-estimating Equation 1, I found no significant moderating effect of hedonic capabilities on firm value ($t = .59$, $p > .56$), while all of my original results held. The nonsignificant effect could be because the overall experience of using a VAF, regardless of what it is being used for, is already perceived by investors to be enjoyable to users, and additional hedonic capabilities do not further enable consumers' experience.

Additional Study: Number of VAF Capabilities

Although I studied the different types of VAF capabilities, it should be noted that Kowalczyk (2018) suggests that the *number* of capabilities a smart speaker has can impact consumers' adoption likelihood – a factor which could ultimately affect investors' belief of the extent to which VAFs enable consumers' experience. As firms have ultimate flexibility in deciding how many capabilities to include in their VAFs, the question that naturally arises is whether investors prefer VAFs that have a focused (i.e., lower) number of capabilities or ones that maximize this number to provide consumers with a more expansive experience. To answer this, I asked my independent raters ($\alpha > 94\%$) to reread each of the 96 VAF announcements and code the total number of capabilities that each announcement mentions. This resulted in a quantitative measure termed as Totalnumber ($M = 2.69$, $SD = 1.66$), which I then used in re-estimating Equation 1 from my main study. The results of the model estimation are provided in the first column of Table 7 (Model 5), which reveal that the total number of capabilities mentioned in a VAF announcement has no significant ($t = .16$, $p > .16$) moderating impact on firm value. Next, I ran a second model that

Table 7: VAF Capability Quantity Models

	Model 5	Model 6	Model 7	Model 8
Variable	Estimate(SE)	Estimate(SE)	Estimate(SE)	Estimate(SE)
Intercept	.018** (.007)	.019** (.007)	.019** (.007)	.019** (.007)
Totalnumber	.001 (.000)	-.000 (.002)	---	---
Totalnumber ²	---	.000 (.000)	---	---
Numberinformational	---	---	.003*** (.001)	.004 (.003)
Numberinformational ²	---	---	---	-.000 (.000)
Numberobjectcontrol	---	---	.000 (.000)	.000 (.001)
Numbertransactional	---	---	-.008** (.003)	-.008 (.009)
Numbertransactional ²	---	---	---	.000 (.008)
Firm type	.002** (.001)	.002* (.001)	.004*** (.001)	.004*** (.001)
Firm size	-.002*** (.000)	-.001*** (.000)	-.002*** (.000)	-.002*** (.000)
Time period	.001 (.002)	.000 (.002)	.001 (.002)	.001 (.002)
Competitive intensity	.000 (.000)	.000 (.000)	.000 (.000)	.000 (.000)
Product demand growth	-.002 (.013)	-.003 (.013)	.008 (.013)	.008 (.014)
Industry advertising	.041 (.093)	.046 (.094)	.046 (.092)	.041 (.103)
Platform	.001 (.001)	.000 (.001)	.000 (.001)	.000 (.001)
Inverse Mills	-.000 (.000)	-.000 (.000)	-.000 (.000)	-.000 (.000)
F-statistic	1.40	1.33	2.10	1.74
R-squared (adjusted R-squared)	.128 (.037)	.136 (.034)	.216 (.113)	.217 (.092)
Observations	96	96	96	96

Note: *p-value < .10, **p-value < .05, ***p-value < .01. The numbers in brackets are standard errors

includes a quadratic term (Totalnumber²) since it may be possible that investors appreciate a larger number of capabilities until a threshold is reached (i.e., inverted-U), a consideration also made in recent research of digital capabilities (Wielgos et al. 2021). The results of this nonlinear model are provided in the second column of Table 7 (Model 6) and reveal no significant ($t = .86, p > .39$) nonlinear relationship. In summary, investors do not seem to be concerned with the overall number of capabilities a VAF includes.

I next tested if investors' reactions to VAFs are contingent upon the number of capabilities belonging to each *specific type* of capability. In other words, perhaps VAF announcements that mention a larger number of informational capabilities are rewarded more positively than those with a smaller number. Or, perhaps the negative moderating impact of transactional capabilities (as found in the main study) is more severe for firms that develop and announce a large number of these capabilities. To address these questions, I again asked my independent raters to reread the VAF announcements, and this time code the total number of capabilities mentioned belonging to each of the three capability types. This produced three quantitative measures: Numberinformational ($M = 1.73, SD = 1.26$), Numberobjectcontrol ($M = .72, SD = 1.48$), and Numbertransactional ($M = .22, SD = .44$). Inter-rater reliability was excellent ($\alpha > 90\%$, $\alpha > 94\%$, $\alpha > 97\%$, respective to each measure). Again, I re-estimated Equation 1 with the inclusion of these measures, and the results are shown in the third column of Table 7 (Model 7). Numberinformational ($t = 2.81, p < .007$) and Numbertransactional ($t = -2.49, p < .02$) are each significant, which reveals that the moderating effects of the mention of informational capabilities and transactional capabilities (as found in the main study) each are further moderated by capability quantity. Therefore, investors not only reward firms for simply including informational capabilities in their VAFs, but also for making efforts to include more of these capabilities, thereby expanding

consumers' easy access to information and further enabling consumers' experience. With regards to transactional capabilities, investors not only penalize firms for including such capabilities in their VAFs, but also for emphasizing these features further (in greater quantity). To understand whether either of these moderating effects reaches a breaking point, I ran a nonlinear model by including quadratic terms of each of the variables (i.e., $\text{Numberinformational}^2$ and $\text{Numbertransactional}^2$). The results are illustrated in the final column of Table 7 (Model 8), revealing that the number of informational capabilities ($t = -.25, p > .80$) and number of transactional capabilities ($t = .01, p > .99$) each have no significant nonlinear moderating effects on firm value. Therefore, dependent on capability type, investors reward (penalize) firms for the number of capabilities they mention in their VAF announcement in a linear fashion.

Discussion

With the advent of Internet of Things (IoT) technology, billions of devices are now connected to the internet. Such proliferation of IoT devices is changing how individuals think, learn, and perform various activities in their day-to-day lives. Tech giants such as Amazon and Google have introduced extremely user-friendly voice assistants for smart speakers, which consumers can access by simple voice commands. Furthermore, these companies allow independent developers to create their own software that expands the capabilities of voice assistants and allows smart speaker users to enjoy additional benefits. Many firms have invested in developing this software (i.e., voice assistant functions, VAFs) to provide value to current and potential new customers. Just as the addition of the internet (Geyskens et al. 2002) and mobile (Cao et al. 2018) channels enhanced firm value, firms expect to reap financial benefits from their investments in VAFs, but no research has explored this. Rather, extant research has focused on IoT technologies (e.g., smart

objects, smart speakers) at a broad level, often from the consumer perspective by focusing on consumer use (Kowalczyk 2018) and adoption intention (Mulcahy et al. 2019). To address this gap, my research explores the value of VAFs from the investor point of view, as investors consider the potential benefits and costs involved in developing such innovations (Boyd et al. 2019) and directly influence firm value through their stock investment actions (Sorescu et al. 2017). I conduct an event study of VAFs launched by publicly traded firms between 2016 and 2020 to learn whether investors perceive this new channel to be a valuable business endeavor, and which types of factors may lead investors to reward certain firms more positively than others. In the following sections, I discuss the theoretical and managerial implications of my findings, in addition to directions for future research.

Implications

With my event study, I find that VAF announcements are positively received by investors, leading to an average .32% increase in firm value. From a theoretical perspective, this positive effect is likely due to investors appreciating the benefits VAFs can produce for firms from both the supply (firm) and demand (customer) side. For example, transaction costs may be reduced as AI-enabled automation can provide operational efficiency gains (Sorescu et al. 2011), and VAFs can allow firms to reach and provide value to existing and new customers (Kim et al. 2015). The supply-side and demand-side framework has been used by marketing scholars to theorize investors' positive reaction to internet (Geyskens et al. 2002) and mobile (Cao et al. 2018) channel additions; I contribute to the marketing literature by extending this framework to the third digital revolution (Novak and Hoffman 2019). From a managerial perspective, since my findings provide evidence that investors reward firms that have developed and announced VAFs, I recommend firms that

have not yet done so to seriously consider it. As I found no time-varying effects, my results suggest that investors continue to value VAFs in a market that has already existed for more than five years. Of course, new entrants should carefully weigh the implications that VAFs have for their business, as investors are only one type of stakeholder whose perceptions should be considered.

With my analysis of moderating variables, I find that the overall positive impact of VAF announcements on firm value is dependent on several factors. From a theoretical perspective, my results support the assemblage theory of Novak and Hoffman (2019). As both consumers and smart speakers affect and are affected in turn by the assemblage that emerges from their interactions, positive and negative consumer experiences can result. When firms develop VAFs and allow consumers to download them, they modify smart speakers and their contributions to the assemblage. The new, resulting assemblage may implicitly enable or constrain consumers' experience (DeLanda 2016), depending on how consumers' expressive or communal role is affected. By extending the work of Boyd et al. (2019) and Cao et al. (2018) to the voice channel, I theorize that different types of VAF capabilities, along with firm type, may have different effects on consumers' experience – investors may therefore reward firms for factors that enable consumers' experience and penalize firms for factors that constrain consumers' experience. First, I find that investors reward firms that mention informational capabilities in their VAF announcement, since these capabilities allow consumers to self-extend (Hoffman and Novak 2018) parts of their identity by indicating their preferences and providing other forms of personal information to their smart speakers, which can enable consumers' experience as consumers begin to self-expand as well (Aron et al. 1992). Second, although I expected investors to penalize firms that mention object-control capabilities in their VAF announcement, since self-reduction (Hoffman and Novak 2018) may occur as consumers' ability to use the smart objects they already

own may be hampered, I found that no such effect exists. This could be because investors may be satisfied with the quality of the functionalities that object-control capabilities provide and may not worry that the omission of other functionalities could lead to lower consumer engagement. For example, investors may believe that the object-control capabilities included in VAFs match the most popular functions that exist in the firms' smart objects that are being controlled, and therefore neither have enabling nor constraining effects on consumers' experience. Third, I discover that firms that mention transactional capabilities in their VAF announcement are penalized by investors, likely due to the fact that consumers' experience is constrained since they are locked into a repetitive assemblage where they mainly repurchase orders made in the past. In addition, transactional capabilities can alienate consumers who do not have a pre-existing relationship (e.g., account) with the firm, which could impede new customers from enjoying a richer assemblage. Finally, I learn that investors emphasize whether a firm offers products or services when determining the value of a firm's VAF. More specifically, firms that primarily sell products are rewarded more positively for their VAFs than those that primarily sell services. Since product firms are able to add a new dimension to the physical nature of their products by engaging with customers in their homes, investors seem to appreciate the enabling benefits that can result from their VAFs.

From a managerial perspective, my analysis of moderating variables (and additional study) provides evidence that investors do not reward firms for their VAFs in a uniform fashion. The specific capabilities that firms choose to include in their VAFs, in addition to the underlying type of business that defines a firm, are important factors that influence the extent to which investors reward firms. This fact leads to a number of managerial implications. First, as informational capabilities have a positive moderating impact on firm value, I recommend managers to strongly

consider including features that provide consumers with easy access to information, whether it is presented automatically or can be accessed through question-and-answer format. Informational capabilities provide users with extremely personalized feedback from their voice assistants, which enhances their experience and is rewarded by investors. Second, as object-control capabilities do not have a significant moderating impact on firm value, this signifies that investors are indifferent to their inclusion within firms' VAFs. Therefore, I recommend managers to not worry about whether including object-control capabilities in their VAFs may hurt consumers' experience through lower engagement with the smart objects they are controlling. Third, as transactional capabilities have a negative moderating impact on firm value, I recommend that managers be cautious regarding the inclusion of such features within VAFs. While these capabilities at surface level may enhance customer spending (Kushwaha and Shankar 2013), they mainly focus on customers who have a pre-existing relationship with the firm, and rarely allow existing customers to purchase new (as opposed to previously purchased) products. I recommend that managers be aware of the penalty that investors place on transactional capabilities, and perhaps consider expanding consumers' experience in the future by making infrastructural changes which (1) allow consumers to purchase a wider variety of products and services, and (2) make VAFs more directly accessible to new customers who do not have an existing account. For example, rather than requiring customers to link their existing account to a VAF through external platforms (e.g., website, mobile app) as is currently the case, firms could begin to build capabilities that allow new customers to open an account directly through VAFs. Fourth, based on the findings of my additional study, I recommend that managers be aware that not only does the mere inclusion of informational and transactional capabilities in a VAF have a moderating impact on firm value, but also the number of each type of capability. Firms whose VAFs have a larger number of

informational capabilities are rewarded more by investors, while firms whose VAFs have a larger number of transactional capabilities are penalized more. Therefore, managers should begin with my main study's guidance regarding the directional effects of these types of capabilities and be aware that my additional study further validates the suggestions I make. Finally, as I find that firm type has a significant moderating impact on firm value, I advise the managers of product firms to be cognizant of the distinct value that investors place on their VAFs. Since product firms suffer from the fact that their offerings are not consumed immediately at the point of purchase (unlike service firms), their ability to follow up with their customers is weakened. VAFs provide a unique opportunity to such firms, who now have the ability to engage with their customers in their homes and provide them with new forms of value and experiences.

Directions for Future Research

As my research makes one of the first attempts to analyze VAFs specifically – as opposed to prior work that focused on broader domains, such as smart objects and smart speakers – I believe a plethora of opportunities exist for research that could help scholars and managers understand the implications of this technology. I collected data on a narrow time window, and my findings may not be representative of all firms releasing VAFs subsequently. Therefore, future researchers should collect more data over a longer period of time and try to corroborate my findings. More research is needed in this space, as digital business transformation is not always easy for firms to accomplish (Wielgos et al. 2021). I next outline several topics that warrant further examination in this domain.

Privacy concerns Consumers, firms, and regulators have become increasingly concerned about privacy and the ways in which online data are handled (Thomaz et al. 2019). In the past couple of

years alone, firms such as Microsoft, Estée Lauder, Walgreens, and Marriott have suffered data breaches in which tens of millions of customer records were exposed. As news reports about such data breaches occur with increasing frequency, consumers get more and more sensitive about the effect of new technologies on the privacy of their data. VAFs require consumers to use a radically new technology (the voice channel) to share a wide variety of personal and interactional data, and this may add an additional layer of nervousness about privacy and data security in their minds.

Cross-channel effects VAFs make available another channel for consumers to seek information and make purchases. It will be interesting to explore the effects that VAF usage has on consumers' use of other channels (e.g., internet, mobile, offline). Are the effects cannibalistic or complementary? Are the effects symmetrical? Which channel gains more? Researchers can study the effects on business outcomes, such as purchase frequency and quantity (Shankar 2018).

Recommendations and advertising Firms use algorithms and tracking methods (e.g., cookies) to make product recommendations that can assist consumer decisions (Gai and Klesse 2019; Tsekouras et al. 2020). In addition, advertising (paid, owned, or earned) is used to keep customers informed of firms' activities and offerings (Srinivasan et al. 2016). Currently, firms do not have the ability to initiate communications, such as recommendations or advertisements, on voice assistants. Nevertheless, emerging research has begun to study the effects of hypothetical advertisements on voice assistant platforms (Lee and Cho 2020; Smith 2020) with the expectation that someday Amazon and Google may change their policies to allow firm-initiated communications. Hence, I recommend that researchers follow this topic closely and try to determine the consequences of recommendations and advertisements through VAFs.

Social capabilities Although mobile apps have a variety of social capabilities that allow peer-to-peer interaction (Boyd et al. 2019), no VAF currently allows a consumer to interact remotely with

other consumers, publish or read product reviews, or participate in discussion forums. This could change, as the growth of social media may spill over into the VAF domain and allow firms to further modify the assemblage by letting consumers interact with others. Thus, I recommend that researchers be aware of this potential shift, as it could be interesting to study how VAFs affect consumers' use of social media. In addition, future research could study whether the experiential (i.e., hedonic) benefits resulting from social capabilities differ from that of existing hedonic offerings such as games, quizzes, and music.

Anthropomorphism of VAFs In the context of human-robot interactions, recent research has shown that anthropomorphism of robots exerts a strong positive effect on consumers' intention to use a robot (Blut et al. 2021). Extrapolating this to VAFs, greater anthropomorphization of VAFs should lead to greater use of VAFs. One way to increase anthropomorphization is to further personalize the voice assistant. For example, Amazon recently added the ability to change the voice of Alexa to that of Samuel L. Jackson, the Hollywood actor (Parrish 2021). However, while Mr. Jackson can tell users a joke or story, check the weather, and set an alarm (among other capabilities), he cannot help users make purchases or use Skills (i.e., VAFs). This presents a clear opportunity that firms can capitalize on. For example, firms with famous spokespeople (e.g., GEICO's gecko), characters (e.g., Disney's Mickey Mouse), or other pop culture icons could anthropomorphize their VAFs further by personalizing the voice used to communicate with consumers. Researchers could study this phenomenon and its impact on consumers and firms.

Competition Competition for a firm's VAF can arise from third-party VAFs that provide the same benefits to users that the firm's VAF provides. Researchers can study the implications of this competition for firms' strategies and how they change over time.

Monetization Prior literature in the area of mobile apps has recognized that free apps can reduce consumer uncertainty regarding the quality and fit of apps, although their free nature can also damage the adoption speed of paid apps (Arora et al. 2017). While most VAFs are presently free for users to download, VAF developers can earn revenue by allowing consumers to purchase in-VAF consumables. Although Amazon charges a 30% fee from these transactions, it only earned \$1.4 million in the first ten months of 2019, well short of its \$5.5 million projection (Kinsella 2019). This could be due to the fact that very few VAFs have been built with in-VAF purchase options. I recommend that researchers explore this issue further to understand consumers' perceptions of microtransactions within the voice channel domain, and subsequently produce strategic insights that could be used by firms to influence the development of in-VAF purchases.

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