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Technology and Minimum Differentiation in the Delivery of Retail Banking Services

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Abstract

In the age of electronic commerce, technology has become vitally important to the provision of retail banking services. This study develops a linear location model where bank customers can identify a bank's relative emphasis of technology versus human resources in the delivery of retail banking services only by establishing a customer relationship. The value of a particular distribution mix to a bank is related to its ability to retain consumers who sample its services. When consumers are non-complacent, differentiation may occur given certain conditions on the number of firms, the duration of the market, and the discount rate. If the conditions for differentiation are met, the extent of differentiation is a non-monotonic function of the level of consumer complacency with respect to departures from the consumer's preferred distribution mix. The equilibrium configuration of distribution mixes may or may not reflect underlying consumer preferences.

1. Introduction

In the age of electronic commerce, technology has become vitally important to the provision of retail banking services. A 2018 study by Raddon, a research subsidiary of Fiserv, reports that 88 percent of consumers used online banking in 2017, up significantly from 46 percent in 2007 (Cornelison, 2018). Likewise, over the 5-year period between 2012 and 2017, the number of consumers engaging in mobile banking increased from 20 percent to 57 percent. However, the same study reports that 77 percent of consumers visited a branch at least once a month during 2017 and that 60 percent of consumers preferred a combination of self-service, digital and in-person banking options. Similarly, the McKinsey & Company 2016 Retail Banking Multichannel Survey reports that 63 percent of US consumers prefer using more than one distribution channel for their banking needs including face-to-face interactions at physical branches and technology-based channels like automated teller machines (ATMs),

internet banking and mobile banking (Dallerup et al., 2018). A 2013 study by the CEB Tower Group projected an increase in online banking transactions from roughly 30 billion to approximately 34 billion transactions per year between 2011 and 2015 and an even more dramatic increase in mobile transactions, approximately 6 billion to about 17 billion per year over the same time period. Unsurprisingly, they projected a slight down-tick in branch transactions over the 2011 to 2015 period. While the number of technology-based transactions outnumber branch-based transactions, their study showed that customers' stated channel preference slightly favored the face-to-face, human-resource based delivery channels when both channels are perceived to be equal in quality. And customers prefer different channels for different functions, preferring online channels for researching and accessing services and face-to-face contact for completing purchases or resolving problems. Furthermore, the study showed evidence that customers value access to brick-and-mortar locations; almost one-fifth of customers who left a bank reported that their reason for doing so was that they had moved to a location where there were no local branches. A 2019 study by the Deloitte Center for Financial Services reports that, net, more than 3,000 branches have been shut down in the U.S. since 2010 in response to pressures to cut costs and customers' shifting preference toward technology-based banking channels (Srinivas and Wadhwani, 2019). However, the results of their survey of 17,100 banking customers across 17 countries also revealed that branches are customers' preferred channel for opening new accounts and that experiences with branches are more important in determining customer satisfaction than experiences with technology-based channels, like online and mobile banking. Xue, Hitt and Chen (2011) provide evidence that customers who adopt online banking services subsequently increase the number of transactions they conduct across both online and face-to-face channels and that online banking adopters living in areas with high branch density increase their demand for loan accounts and investment accounts more than those living in low branch density areas. Their results suggest that online and face-to-face banking channels may work together as complements, consistent with the results of Calisir and Gumussoy (2008) who focus on the preferences of young consumers. This evidence suggests that while technology in the delivery of retail banking services is important and will likely continue to become more so, human resource-based provision at branches will continue to be an important part of the distribution mix for retail banking services. Although there has been much recent interest in the roles of

technology and human resources in the provision of retail banking services, there has been an absence of rigorous theoretical modeling of a bank's choice over its retail distribution mix.[1] This study attempts to fill this gap.

If banks do maintain both technology-based and human resource-based delivery channels, the relative levels of resource commitment may not be readily observable without actually consuming a bank's services, at least within certain ranges of distribution mix. For example, brief inspection might indicate the number of branches, their hours, the number of ATMs, and the existence of tele-banking, personal computer (PC) based banking, or mobile banking options, but the relative commitment of bank resources to these elements of its distribution system may become apparent only after experiencing waits for tellers or tele-bankers, meeting with a less than knowledgeable personal banker, finding ATMs out-of-service, or experiencing the inability to connect to PC- or mobile-based services. Of course, some banks might commit exclusively to technology-based or human resource-based distribution without ambiguity, and in doing so capture certain segments of a larger market, but where they choose to offer both there may exist a range of mixes where the relative commitment of resources is observable only through customer experience. This study focuses on this market segment.[2] If there are ranges where distribution mix is not observable by inspection alone, this raises the question of whether banks would be expected to maintain technology/human resource mixes similar to their

[1] For additional discussions on the role of technology versus human resource-based provision of banking services see, Sousa, Amorim, Rabinovich, and Sodero (2015), Geng, Abhishek and Li (2015), Xue, Hitt, and Chen (2011), Calisir and Gumussoy (2008), Xue, Hitt and Harker (2007), Bradley and Stewart (2003), Black, Lockett, Ennew, Winklhofer, and McKechnie (2002), Thornton and White (2001), Yakhlef (2001), Daniel (1998), Frei, Harker, and Hunter (1997), Prasad and Harker (1997), Barczak, Ellen, and Pilling (1997), Humphrey and Pulley (1997), Kimball, Frisch, and Gregor (1997), Kimball and Gregor (1995), Holliday (1995), Humphrey (1994), and Parsons, Gotlieb, and Denny (1993). Licht and Moch (1999) examine the role of technology innovation in the overall service industry.

[2] Nelson (1970) denotes goods and services whose qualities can be determined only through consumption as experience goods.

competitors or whether they would seek to differentiate themselves along these dimensions within these ranges. This article examines this question using a variant of the simple linear model developed by Hotelling (1929) in his classic work on location theory.[3]

Hotelling showed that, where prices were exogenously determined, firms in a duopoly setting would locate back to back in the center of a finite one-dimensional market. This finding became known as the principle of minimum differentiation. The significance of the Hotelling result is that the observed location pattern is not socially optimal. A social planner concerned with maximizing the benefit of all market participants would choose to locate firms at equidistant intervals on the line so as to minimize societal "transportation" costs. Hotelling's result suggests that competitive firms concerned only with profit maximization do not reach this result. In general, the principle of minimum differentiation is quite sensitive to the underlying assumptions.[4]

Hotelling's concept of location easily extends to any product characteristic. Firms may choose any "location" along a product dimension such as durability or quality. Thus, the concepts apply to any form of horizontal differentiation. The analysis that follows considers these issues with respect to a market where preferences over distribution mix are consumer specific, distribution mix cannot be observed in advance, and information about distribution mix cannot be accurately communicated between consumers or between banks and consumers. The value of a particular distribution mix to a bank is related to whether consumers who sample a bank are more likely to remain with that bank than to search for an alternative closer to their preferred distribution mix.

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[3] A modified Hotelling model is also used by Matutes and Vives (1996) to model competition in the banking sector. In their model there is tension between rate competition and expected failure probabilities. Coordination problems among depositors lead to multiple market equilibria.

[4] Hotelling's work spurred a flood of research much of which involves altering one or more of the assumptions underlying Hotelling's original model. Graitson (1982) provides an excellent review of the literature up to early 1980's.

The next section presents the formal assumptions. Section III presents the results. A final section summarizes.

2. The Model

The motivation for the model is related to the following stylized facts. Over the last 20 to 30 years, banks have increasingly provided electronic based services. In some cases/areas, branches seem to be disappearing but in others new branches are being built. What type of model might explain these phenomena? It occurred to us that certain types of consumers might be driving things.

As an example, consider a 65-year-old head of household, who may have multiple bank accounts, who simply won't do business with a bank unless it has an easily accessible branch in his/her geographic area. This individual, call him "Boomer," is used to doing business in person and wants to be able to resolve any issues face to face. Boomer also has need for access to a safety deposit box and an ATM, for he needs to store assets and papers and frequently pays for things in cash. He is averse to doing any more online than necessary to due to privacy and identity theft concerns. At least for his primary banking relationship, Boomer insists on a local branch. However, Boomer may have other accounts, which are accessed infrequently (like a certificate of deposit), for which a nearby branch is less critical. In the model's terminology Boomer's preference for distribution mix (designated as Ψ in the model) for his primary relationship is close to one (a preference for pure bricks and mortar provision of services). For his secondary accounts, his Ψ may be smaller (a nearby branch is less critical).[5]

Consider a second individual, a 25-year-old single, who has a single bank account, and could care less about a local branch because she conducts her banking and, indeed, her life on her smart phone. As

[5] There is no requirement of a one-to-one relationship between a "customer" and a "physical person" nor even that a physical person have the same Ψ for all of his or her customer relationships. It is, however, required that each Ψ be equally profitable to the competing banks. A survey available at gobankingrates.com suggests about half of Americans have accounts at multiple banks and the likelihood of this varies with age and gender of the primary account holder, which is consistent with the examples and model developed here

long as she can access her balance, make payments, and transfer cash to payments applications electronically, she is perfectly happy with her banking service. Call this individual "Millie". Millie's preference for distribution mix (i.e. her Ψ) will be closer to zero (i.e. a preference for electronic provision).

The bank wants to attract the most profitable mix of Boomers and Millies as possible but has limited capital resources. How does it allocate that capital between the bricks and mortar for Boomer and the electronic resources (which include systems construction, maintenance, and security) for Millie? Since both of these are substantial fixed costs, the bank must choose its own Ψ (i.e. distribution mix) to maximize its profits. We adopt the linear Hotelling model to consider this question.

The results of the following model show that the choice depends on the tolerance of Boomer and Millie for departures from their preferred form of banking, the level of competition, and the cost of capital (i.e. the discount rate), and the duration of the market (which is best interpreted as the stability of the market before some future shock changes everything. For example, COVID-19 may well create a shock to Boomer's preference structure creating, in effect, a different market.)

In the economy there are N risk neutral banks providing retail banking services, M consumers (who may be risk averse) consuming these services, and nature. The market exists for t periods where t is finite, randomly chosen by nature, and unobservable by all parties (except nature) until the last period, T. The objective of banks is to maximize profits over the T periods that the market operates. Each bank is assumed to have a discount function, $\delta^t \leq 1$, over profits received in period t.

Each bank provides retail services along the same iso-cost curve and charges a price for these services that yields a positive per customer profit margin. The restriction to a single iso-cost curve, which precludes other forms of quality competition, is necessary in order to restrict competition to the distribution mix dimension on which we wish to focus. Precluding price competition is necessary to avoid the problems associated with lack of equilibrium in the pricing subgames in Hotelling type models. While price competition is sometimes observed in the market for retail banking services, at least with respect to core deposits, service competition may be relatively

more important in this market so that this assumption is hopefully not too serious a departure from reality.[6] A positive per customer profit margin is necessary for banks to be concerned about choice of distribution mix. The services delivered on the iso-cost curve vary along a single dimension called distribution mix, designated ψ, which may be modeled as a line segment with its left endpoint representing the heaviest emphasis on technological distribution such that the distribution mix cannot be detected by inspection (normalized to 0) and its right endpoint representing the heaviest emphasis on human resource based distribution such that the distribution mix cannot be detected by inspection (normalized to 1). Banks that choose distribution mixes beyond the endpoints (and thus signal distribution mix), and the customers who prefer such mixes, are assumed to constitute separate markets. Prior to period one, each bank must choose to offer a particular distribution mix ψ_k, which is fixed for the duration of the market. This assumption reflects the fact that technology-based distribution requires a commitment to equipment and technical expertise that is reversible only at a high cost. Per period per customer profit, $\pi_{kit} > 0$, is constant across distribution mixes and periods. The assumption that π_{kit} is positive and constant across t and k implies that the bank's objective is to maximize its expected share of the retail banking services market.

Each consumer has an exogenously determined identical demand of one service episode per period. Each consumer has a preferred distribution mix for retail banking services, ψ_i^*. The preferences of the M consumers over distribution mix are assumed to be uniformly distributed along the unit interval of the market. In period one, consumers choose a bank at random and observe the distribution mix

[6] Frei, Kalakota, Leone and Marx (1999) suggest that competition, processes, and technological innovation have shifted the strategic focus from price to service quality in the retail banking industry. They present a model in which banks maximize market share (and hence profits) by minimizing variation in the service delivery process. Winton (1997) presents a model in which rate competition is inhibited by the agency cost of debt. He suggests this leads to collusion among financial intermediaries, but he does not consider the possibility of competition along the service quality dimension. Zephirin (1994) considers a model where banks increase service quality for depositors with good reputations which create switching costs that allow the bank to pay lower interest rates on deposits.

of services delivered. They will remain with that bank so long as the bank is within α units of their preferred distribution mix, ψ_i^* (i.e. the bank's distribution mix is in the interval $[\psi_i^* - \alpha, \psi_i^* + \alpha]$). If the bank is not within α units of their preferred distribution mix, the consumer will choose a bank at random next period, and so on each period, until they find a bank whose distribution mix they can tolerate. Consumers are assumed to sample with replacement. The parameter α serves as a measure of consumer complacency.[7]

The distribution mix chosen by each bank is observable only by consuming services from that bank. Banks cannot convincingly communicate distribution mix to consumers nor can consumers convincingly communicate the distribution mix of any particular bank to another consumer. The assumption that consumers cannot meaningfully communicate to one another regarding the distribution mix of a particular firm is made because consumers are heterogenous and do not have knowledge of the preference structures of other consumers. What constitutes a reasonable waiting time for a teller to one consumer might be intolerable for another consumer. What is an acceptable level of ATM downtime or mobile-banking technical issues to one consumer might be unacceptable to another. Thus, information asymmetry and heterogeneity limit the role of reputation in the market.[8] Banks can choose to signal distribution mix by choosing an extreme form, but this places them beyond the endpoints of the market being considered. Banks choosing to remain within the market are implicitly trying to appeal to consumers with different preferences over distribution mixes and thus have little incentive to announce the particular distribution mix chosen. In any event, such

[7] While the assumption that consumers sample firms with replacement is made primarily for mathematical convenience, this might occur, for example, because consumers do not know that ψ_k is fixed. The values of ψ_i^* and α can be thought of as being derived from a more complicated model incorporating various consumer characteristics. See, for example, Pitchik and Schotter (1993).

[8] Allowing consumers to learn from other consumers simply allows a subset of consumers to find banks within their tolerance levels more quickly (i.e. the steady state referred to below is reached more quickly). Including such learning in the model results in an increase in complexity without changing the qualitative results.

announcements would constitute "cheap talk" by banks and, hence, are not convincing. Consequently, for banks in the interval being modeled, a bank's distribution mix can be observed only by experiencing a service episode with that firm.

There is an important distinction between the location models of the literature and our model of bank and consumer behavior. Here, consumers can observe the distribution mix of banks only by actually sampling from them. In traditional models, firms could be assured of attracting and retaining consumers who are located "closer" to them than to other firms. In the current model, "location" is not observable without sampling and this is not true. Banks retain "nearby" individuals in subsequent periods only if the individuals sample the bank and find its level of distribution mix sufficiently close to their preferred distribution mix that they search no further. Another bank closer to the individual's ψ_i^* may be present in the market, but if the consumer is sufficiently satisfied with his existing bank no further search will be conducted. (i.e. The *i*-th consumer sampling any bank offering services at distribution mixes in the closed interval $[\psi_i^* - \alpha, \psi_i^* + \alpha]$, will remain with that bank and will not search in future periods.) Thus, the value of a distribution mix is related to whether it affects the number of consumers who sample the bank and the likelihood that consumers will remain with a bank. Given the pricing and profit assumptions, the banks' objective function is then equivalent to maximizing the sum of the discounted value of the bank's expected market share.

3. Distribution Mix Differentiation

If consumers in the market have identical α's (i.e. $\alpha_i = \alpha_j \; \forall \; i,j \in M$), then the bank's choice of distribution mix that maximizes profits in the long-run depends upon the level of α.[9] The expected profit of a bank over the life of the market is

$$\boldsymbol{E}[\prod] = \sum_{\boldsymbol{t=1}}^{\boldsymbol{E[T]}} \sum_{\boldsymbol{i=1}}^{\boldsymbol{E[m_t]}} \boldsymbol{\delta^t \pi_{kit}} \qquad (1)$$

[9] Note that the assumption of identical α's (i.e., α is a point mass) is not unreasonable. In our example, Boomer and Millie have radically different preferences over distribution mix, but they may be equally intolerant if the bank does not provide the mix they prefer.

where m_t is the number of consumers consuming from the n-th bank in period t, π_{kit} is the per customer profit in period t for a bank choosing distribution mix k, and δ^t is the bank's discount function. The only uncertainty regarding m_t results from the distribution mix decisions of other banks and the random sampling choices of searching consumers. Note that although payoffs are received over multiple periods the bank moves only once and therefore the choice of distribution mix is the solution to a one-shot game. The bank then seeks to choose a mix, ψ',

$$\boldsymbol{E}\left[\prod\left(\boldsymbol{\psi}_{\boldsymbol{j}}', \boldsymbol{s}_{-\boldsymbol{j}}\right)\right] \geq \boldsymbol{E}\left[\prod\left(\boldsymbol{\psi}_{\boldsymbol{j}}, \boldsymbol{s}_{-\boldsymbol{j}}\right)\right] \quad \forall\, \boldsymbol{\psi}_{\boldsymbol{j}} \in \boldsymbol{\Psi};\ \boldsymbol{s}_{-\boldsymbol{j}} \in \boldsymbol{S}_{-\boldsymbol{j}} \tag{2}$$

where s_{-j} stands for the distribution mix choices of all banks except j,

$$\boldsymbol{s}_{-\boldsymbol{j}} = \left(\boldsymbol{\psi}_{\boldsymbol{1}}, \boldsymbol{\psi}_{\boldsymbol{2}}, \ldots, \boldsymbol{\psi}_{\boldsymbol{j-1}}, \boldsymbol{\psi}_{\boldsymbol{j+1}}, \ldots, \boldsymbol{\psi}_{\boldsymbol{N}}\right) \tag{3}$$

and S_{-j} is the set of all possible distribution mix choices for all banks except j. A combination of mixes, $\psi^* \in \Psi$, is a Nash equilibrium if

$$\boldsymbol{E}[\prod(\boldsymbol{\psi}^*)] \geq \boldsymbol{E}\left[\prod\left(\boldsymbol{\psi}_{\boldsymbol{j}}, \boldsymbol{\psi}_{-\boldsymbol{j}}^*\right)\right] \quad \forall\, \boldsymbol{\psi}_{\boldsymbol{j}} \in \boldsymbol{\Psi};\ \boldsymbol{j} \in \boldsymbol{J} \tag{4}$$

where J is the set of all banks. In general, even with identical α's, there are multiple Nash equilibria to the game. However, the structure of the market permits a few observations of note about the distribution mix choices of banks.

Proposition 1. If $\alpha < .5$ and $N > 2$, the likelihood of minimum differentiation (i.e. banks in the market are clustered at .5) is positively related to the number of banks, N, and inversely related to the discount factor, δ, and the expected number of periods, E[T].

Proof. For a set of N banks, assume the other N-1 will exhibit minimum differentiation. Consider the distribution mix decision of the Nth bank. Define the market share of a bank in period t that has chosen distribution mix k as s_{kt}. Then since $E[m_t] = E[s_{kt}]M$, expected profit of a bank in period t, is

$$\boldsymbol{E}[\boldsymbol{s}_{\boldsymbol{kt}}]\boldsymbol{M}\boldsymbol{\pi}_{\boldsymbol{kt}} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{E}[\boldsymbol{m}_{\boldsymbol{t}}]} \boldsymbol{\pi}_{\boldsymbol{kit}} \tag{5}$$

To simplify notation let s_{kt} equal its expected value. If the bank locates at the cluster (call this location 0), the bank's expected market share is $1/N$ in the first period and

$$\boldsymbol{s_{02} = s_{0N} = \frac{2\alpha}{N} + \frac{(1-2\alpha)}{N}} \tag{6}$$

in the second and subsequent periods (including period N), which represents its pro rata share of consumers who tolerate its distribution mix and its pro rata share of searching consumers.

First, consider the optimal deviation of a bank that is considering differentiating itself. The bank can retain all consumers who are in the interval $[\psi-\alpha, \psi+\alpha]$. Thus, a bank that locates closer to the endpoints than α, forgoes part of its retention power and, since the remaining banks are clustered at the midpoint, gains nothing from doing so. Thus, a deviating bank will locate in the interval $[\alpha, 1-\alpha]$. However, if deviation is optimal it must be because the bank ultimately receives higher expected profit from and hence greater expected market share from the deviation. The bank maximizes expected market share by locating at the points in the interval $[\alpha, 1-\alpha]$ that minimize overlap with the banks clustered in the center. For all $\alpha < .5$, this occurs at the points α and $1-\alpha$ and, thus, these are optimal potential deviations.[10] Now suppose the bank decides to locate at a point on the line equal to α. Consider two cases dependent on the value of α (designated locations 1 and 2, respectively):

Case 1. ($\alpha < 1/6$).[11] In period 1, the bank has expected market share $1/N$. In period 2 it has expected market share

[10] For $\alpha < 1/6$, the first bank to deviate would be indifferent to any location on the intervals $[\alpha, .5-2\alpha]$ and $[.5+2\alpha, 1-\alpha]$. Although we assume deviation occurs at α, the proof of Case 1 is unchanged if a different point in these intervals is chosen.

[11] As a measure of consumer complacency, the larger α is, the more complacent consumers are. Thus, $\alpha < 1/6$ indicates that consumers are relatively non-complacent. Non-complacent customers are more likely to search for a different bank and more complacent customers are less likely to search.

$$s_{12} = \frac{2\alpha}{N} + \left(\frac{1-4\alpha}{N}\right) \tag{7}$$

The value of s_{1t} increases monotonically in t until in period N and thereafter the bank has expected market share

$$s_{1N} = 2\alpha + \frac{(1-4\alpha)}{N} \tag{8}$$

representing its own clientele and its share of searching consumers. Now, $s_{02} > s_{12}$, but $s_{0N} < s_{1N}$. Substituting (5) into (1) and using (2) it becomes apparent that the advantage to deviating from minimum differentiation increases the more quickly the steady state market share, s_{1N}, is reached, which will occur more quickly for smaller N. Also, the longer the profits associated with s_{1N} are received the greater the benefit for differentiation. This increases with E[T]. The advantage of differentiation also increases the less the bank discounts profits received in future periods. Higher δ implies lower discounting.

Case 2. (.5 > α > 1/6).[12] The differentiating bank has market share 1/N in period one and expected market share

$$s_{22} = \frac{2\alpha}{N} + \left(\frac{.5-\alpha}{N}\right) \tag{9}$$

in period two. The value of s_{2t} increases monotonically in t until in period N and thereafter the bank has expected market share

$$s_{2N} = (.5 - \alpha) + \frac{(3\alpha-.5)}{N} + \frac{(.5-\alpha)}{N} \tag{10}$$

representing its own clientele, that portion of its clientele that overlaps with banks in the center, and its share of searching customers. As before, $s_{02} > s_{22}$ and $s_{0N} < s_{2N}$, and the advantage to deviating from minimum differentiation is a function of how quickly the steady state market share, s_{2N}, is reached, which is in turn a function of N, the length of time that the steady state endures, which is a function of

[12] In Case 2, consumers are relatively more complacent than they are in Case 1.

E[*T*], and how much the bank discounts profits received in future periods, which is a function of δ.

Q.E.D.

Corollary 1: For α < .5, if N > 2 but sufficiently small, E[T] sufficiently large, and δ sufficiently close to one, some degree of differentiation will exist and the range of differentiation is negatively correlated with α.

Proof: The existence of differentiation follows directly from (2) given the comparison of (10) and (6), the comparison of (8) and (6), and the substitution of (5) into (1). Since the optimal initial deviations occur no closer to the endpoints than α and 1-α, the range of any bank dispersion will be negatively related to α.

Q.E.D.

The most surprising and interesting implication of Proposition 1 and its Corollary is that consolidation within the banking industry may actually lead to an increased likelihood of distribution mix competition on the part of the remaining firms. This occurs because a firm pursuing an alternative strategy realizes gains from its deviation more quickly the fewer competitors there are in the market. Consumers find the bank matching their preferred distribution mix more quickly.

If the conditions for differentiation are met, following procedures similar to those in Prescott and Visscher (1977), one can show an equilibrium exists where banks are dispersed with a finite number (which is a function of α) of distribution mixes and banks cluster in equal numbers at the respective mixes. If relocation is prohibitively costly, the socially optimal equilibrium, where banks are spaced at intervals of 1/*N*, is possible. Although such an equilibrium can exist, there is clearly no guarantee that any differentiation will exist, even for low levels of α. If the number of banks is too large, the expected duration of the market too short, or banks discount future profits too greatly, minimum differentiation will hold. Again, these results are interesting because they suggest that there may be a societal cost associated with unrestricted entry of banks into a particular market. We next consider the case where consumers are relatively more complacent.

Proposition 2. If α ≥ .5, banks will choose distribution mixes randomly along the interval [1-α, α].

Proof. At any point in the interval, the bank retains all its original customers because it covers the market. At any point outside the interval some of its customers will search. Assuming other banks are rational, and that there will thus be no other searching customers in the market, the bank maximizes expected market share by minimizing the number of its customers who search and hence chooses a mix in the interval.

Q.E.D.

Corollary 2. If α = .5, banks will exhibit minimum differentiation.

Proof. By Proposition 2 all banks choose distribution mixes on the interval [1-α, α] if α ≥ .5. But at α = .5 the interval collapses to a single point, .5, and all banks choose the mix in the center of the line at this point.

Q.E.D.

Whenever α > .5, distribution mixes are random along the interval [1-α, α], collapsing to minimum differentiation as α decreases toward .5. These results suggest that, if the conditions for differentiation suggested in the Corollary 1 are met, differentiation in bank distribution mix is a non-monotonic function of α. If α < .5, increasing α decreases differentiation, but as α increases above .5, increasing complacency leads to greater bank distribution mix differentiation. When α > .5, the observed differentiation need bear no relation to consumers' preferred distribution of mixes, but when α < .5, if banks differentiate, it will be in a manner that bears some relation to the distribution of consumer preferences. Frei, Kalakota, Leone and Marx (1999) report that banks with higher customer satisfaction also have higher price earnings multiples (suggesting the market expects greater earnings growth from such banks), which suggests that α may be small enough to constrain bank behavior.

4. Conclusions

This study has shown that where preferences over the use of technology versus human resources in the distribution of retail banking services are consumer specific, distribution mix cannot be observed in advance, and distribution mix cannot be accurately

communicated between consumers or between banks and consumers, the degree of horizontal differentiation in the market will be related to the degree to which consumers tolerate departures from their preferred distribution mix without switching banks. If consumers are relatively non-complacent, differentiation in distribution mix reflecting consumer preferences may occur if the number of banks is not too large, the expected duration of the market is sufficiently long, and banks do not discount future profits too much. This implies that the smaller the number of banks in a given market, the greater the likelihood of distribution mix competition. If the conditions for differentiation are met, the degree of differentiation is a non-monotonic function of consumer complacency. If complacency is relatively low, banks maximizing market share may be forced to adopt distribution mixes dispersed in a manner reflecting underlying consumer tastes, although the degree of dispersion need not be socially optimal. Relatively more complacent consumers lead to minimum differentiation in distribution mix. Highly complacent consumers lead to a distribution of mixes unrelated to consumer preferences.

The results of the model provide potentially rich implications for future empirical testing. For example, the most surprising conclusion of the model is that a reduction in bank competition actually increases the likelihood that distribution mixes will reflect consumer preferences. If one uses intergenerational differences in Ψ as a motivating factor (e.g., "Boomer" versus "Millie's" preferences), one would expect to see fewer branches and better electronic services in areas with rapid growth in millennial populations (e.g., downtown Nashville) and branch building in areas of rapid growth in retirement populations (e.g., any rapidly growing retirement community in Florida, Texas, or Arizona). The model would suggest, however, that the rate of adaption will actually be faster in areas where there are fewer competing banks. The intuition is that banks capture market share more quickly in areas with fewer competitors, which justifies the capital expenditure. Empirically, we might expect that banks that compete nationally might also be expected to adapt to population changes more slowly because their capital budget commitments may be made at a national level. However, the opposite could be empirically true for national banks. At least for electronic provision of services, the capital commitment is institution wide. But for nation-wide banks, we might expect to see greater variation in branch frequency depending on the makeup of the local population. Thus,

nationwide banks may choose a Ψ that varies with local market conditions by varying its branch building/closing rates with local preferences. In conclusion, the implications of this study's model provide a number of avenues for future empirical work.

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A Change in Perspective: Firm Value, Executive Succession, and Managerial Optimism

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Abstract

We document the board of director's propensity to hire an inside CEO replacement, and changes in firm value around turnover announcements as a function of the optimism of the CEO incumbent and her successor. Our models show boards are more likely to select an internal replacement when she shares the same level of optimism as the incumbent. We find little evidence of significant changes in firm value when an inside successor possesses a more optimal level of optimism than the incumbent. Our results indicate that shareholders benefit when internal replacements possess a level of optimism that simply differs from that of the incumbent. Thus, although boards are more likely to hire internally when they seek to maintain the level of optimism of the incumbent, shareholders tend to benefit when an insider is selected who represents a change in the status quo.

Introduction

The most important function of boards of directors is arguably the decision to replace top-level managers and the choice of an executive's successor. The board evaluates the quality of potential replacements for the CEO from a pool of internal and external candidates by weighing measures of personality, fit and demonstrated skill set. Studies suggest boards should only hire an internal successor when they seek to maintain the status quo (Salancik and Pfeffer, 1980; Lauterbach, Vu and Weisberg, 1999). Other studies document the merits of hiring an outside successor. For instance, Borokhovich, Parrino and Trapani (1996) report that stock prices tend to react positively to the decision to hire externally. Karaevli (2007) and Huson, Malatesta and Parrino (2004) find that external CEO hires can improve firm performance and implement needed changes. On the other hand, outside successors have less company-specific

knowledge, which can hinder them in their execution of new strategic initiatives (Zhang & Rajagopalan, 2010).

Recent studies on CEO quality have focused on a CEO's personality, in general, and the level of her optimism, in particular. A CEO is optimistic if she overestimates project payoffs, on average (Giat, Hackman and Subramanian, 2010). Goel and Thakor (2008) develop a model showing that managerial optimism can be value-maximizing because it mitigates risk aversion stemming from managers' undiversifiable human capital investment in the firm. Managers who lack sufficient optimism and those who are *excessively* over-optimistic will be inclined to underinvest or overinvest, respectively. In Goel and Thakor's model, a shareholder-optimal level of overconfidence exists (moderate optimism), whereby firm value is maximized. Consistent with theoretical models, empirical evidence shows that optimism affects both corporate investment quality and turnover. Campbell, Gallmayer, Johnson, Rutherford and Stanley (2011) report evidence that moderate CEO overconfidence is shareholder-optimal. They find CEOs with excessively low (high) optimism are inclined to under- (over-) invest and are more likely to experience forced turnover.

Our study combines theory and evidence from the CEO turnover and CEO optimism literatures for evidence on how optimism affects the CEO replacement decision. We model changes in firm value around turnover events when insiders are selected to replace the incumbent, as a function of the relative optimism of incumbent and successor. We employ the same three proxies of optimism as in Malmendier and Tate (2005) and Campbell (2014) to measure the optimism of the executives. Specifically, we classify CEOs as having high optimism if: (1) the CEO's net stock purchases are positive, (2) the CEO's purchase exceeds the 80^{th} percentile of all transactions in the sample, and (3) the CEOs increase their stake in the firm by at least ten percent. A CEO has low optimism if: (1) she has negative net stock purchases in a particular year, (2) the transactions are less than the 20^{th} percentile of all such transactions, and (3) the net transaction(s) results in a decrease in her stake in the firm by at least ten percent. The second optimism measure employs the percentile classifications used in our first measure, but includes the CEO's option transactions. Our final optimism measure captures firm-level investment. Specifically, a CEO has high (low) optimism if her firm's three-digit SIC-adjusted level of corporate investment exceeds (is less than) the 80^{th} (20^{th}) percentile of all firms in her industry for two consecutive years. For

all three proxies, CEOs with neither high nor low optimism are classified as moderately optimistic.

Using a sample of both internal and external CEO successions, we first test the board's propensity to choose an internal successor, as a function of CEO optimism. Our first hypothesis predicts that, to maintain the status quo, boards will be more likely to select an *internal* successor when she shares the optimism of the incumbent. Next, we test several alternative hypotheses to explain the change in firm value around the announcement of internal hires. Our second hypothesis predicts that the stock price will react more positively when managers with suboptimal optimism are replaced with moderately optimistic managers, and a more negative reaction when the reverse is true.

Our next two hypotheses offer competing predictions on the wealth effects around turnover events, as a function of optimism of the incumbent and successor, considered together with prior firm performance. First, we examine whether firms could benefit from a simple change in risk-taking perspectives and economic outlook, such as they might find in an external hire. We propose that an internal successor who differs from the incumbent in her level of optimism would have a different economic outlook, and be inclined to critically evaluate the strategic initiatives of her predecessor. As such, the successor would be more likely to discontinue suboptimal projects. The benefits of this critical review should be more pronounced for underperforming firms. Finally, we examine whether the market's expectation of changes in performance is related to the optimality of the optimism of the incumbent versus that of her successor. Our final theory predicts that the market will react most negatively to turnover announcements when well-performing firms replace a moderately optimistic incumbent with an over- or under-optimistic successor. This theory also predicts that shareholders of poorly performing firms should experience the greatest gains when an optimally optimistic successor replaces a sub-optimally optimistic incumbent.

Using seemingly unrelated regressions to model the internal versus external replacement decision, we find that boards are more likely to choose an internal replacement when the successor shares the level of optimism of the incumbent, thus preserving the status quo. Models of two-day cumulative abnormal returns (CARs) around CEO turnover announcements show little evidence that the market reacts more positively (negatively) when boards choose internal successors who improve (worsen) CEO optimism. Interestingly, the evidence shows that *both* well- and poorly performing firms benefit when incumbent

and successor simply have disparate, but not necessarily more optimal, levels of optimism.

Taken together, our evidence suggests that boards tend to choose inside CEO replacements over external replacements when the successor maintains the status quo in CEO optimism. However, this decision is costly, regardless of the optimality of the incumbent's optimism. That is, shareholders tend to benefit when the level of optimism of the inside replacement differs from that of the incumbent.

Review of Literature and Testable Hypotheses

Determinants of the Choice of CEO Successor

Studies document that the board's decision to hire an internal versus outside CEO and the merits of that decision are functions of past firm performance and the relative costs of hiring externally. Extant literature generally finds boards are more likely to hire a firm outsider following periods of underperformance, and that outside hires are more likely to implement optimal strategic changes (Guthrie & Datta, 1998; Huson et al., 2004; Chen and Hambrick, 2012). Borokhovich et al. (1996) find that independent directors are more likely to prefer outside successors and that shareholders benefit from this decision.[1] However, in some instances, outside hires can lack the firm-specific knowledge to successfully implement changes in strategy (Zhang & Rajagopalan, 2004; Zhang & Rajagopalan, 2010). Khurana (1998) reports that boards hire outsiders after a careful vetting process during which the board concludes that an outsider is preferable to any viable inside successor. Parrino (1997) finds that directors tend to seek outside hires when the firms in the industry are homogeneous, as the candidate's abilities can be better observed and their skill set is more transferrable. Relatedly, Naveen (2006) finds that firms designate inside successors when firms are large and diverse, and their industry is heterogeneous.[2]

Managerial Optimism and CEO Quality

Theoretical models and empirical evidence support the notion that the CEO's level of optimism affects the quality of her decision-

[1] See also Hayes and Schaefer (1997), Guthrie and Datta (1998), and Kang and Shivdasani (1995) who also report evidence that external successors are preferred to inside hires. Conversely, evidence that inside successors can be shareholder-optimal is provided by Zajak (1990), Furtado and Rozeff (1987) and Worrell and Davidson (1987).

[2] See Berns and Klarner (2017) for a comprehensive review of the CEO succession literature.

making. Extant evidence shows CEO optimism can affect decisions involving the firm's investment policies, capital structure, dividends and levels of innovation. Goel and Thakor (2008) provide a theoretical framework showing moderately optimistic managers are more likely to accept shareholder-optimal risky projects and are less subject to disciplinary turnover. Giat et al. (2010) find empirical evidence suggesting that moderate optimism reduces the agency costs of risk-sharing. Campbell et al. (2011) find that CEOs exhibiting optimism above or below the optimal level experience a greater likelihood of disciplinary turnover.

Thus, too much or too little optimism can result in the acceptance of high-risk negative NPV projects, or conversely, the rejection of shareholder-optimal risky investments.[3] Because most CEOs have an undiversifiable investment in their firm comprised of both human capital and equity holdings, moderately optimistic managers are more inclined to make shareholder-optimal decisions.

Testable Hypotheses

We incorporate theory and evidence from the executive turnover and optimism literatures to investigate the propensity of the board to hire an internal successor, as well as changes in firm value associated with internal CEO replacement decisions. H1 predicts the likelihood boards will choose an inside successor based on the relative levels of optimism of the incumbent and successor. H2 predicts changes in firm value as a function of the optimism of incumbent and successor. H3a and H3b offer competing theories to explain changes in firm value around turnover announcements, based on changes in CEO optimism considered together with firm performance.

H1: Boards are more likely to choose an inside replacement with the same level of optimism as the incumbent.

Extant studies show directors hire an internal successor to maintain the status quo (Lauterbach et al., 1999; Salancik and Pfeffer, 1980). If directors view the optimism of the incumbent as a positive attribute, we predict that boards will be more likely to choose an internal replacement when the successor shares the level of optimism of the incumbent, regardless of the optimality of that optimism.

H2: The stock price reaction around CEO turnover announcements will be more positive when a moderately optimistic

[3] Chen, Lin and Tsai (2018) provide evidence that high managerial optimism is preferable to moderate optimism for new-product introductions.

successor replaces an incumbent with suboptimal optimism. Conversely, shareholders will react more negatively when a successor with suboptimal optimism replaces a moderately optimistic CEO.

Boards learn more from past successes than failures (Campbell, 2014). Thus, the greatest negative surprise should occur when the firm names a successor with suboptimal optimism following the departure of a moderately optimistic incumbent. We also expect a positive surprise when a moderately optimistic successor replaces an incumbent who is either over- or under-optimistic.

H3a: Shareholders benefit most when directors choose an insider with optimism that simply differs from that of the incumbent. Poorly performing firms will benefit most from disparate levels of optimism among the incumbent and successor.

Studies report that external hires are more likely to initiate necessary strategic changes. However, for some boards, the absence of viable external candidates and their associated lack of firm-specific knowledge contributes to the decision to hire internally. We propose that an insider who differs in her level of optimism from that of the incumbent could offer a reasonable substitute to an external successor. That is, by possessing a different economic outlook, the internal successor would be less likely to favor the incumbent's non-optimal initiatives, and be better positioned to drive strategic change that benefits shareholders. We expect underperforming firms to benefit more from changes in optimism, as these firms have greater opportunities for performance gains.

H3b: Shareholders of well-performing firms are harmed when a sub-optimally optimistic successor replaces an incumbent with moderate optimism. Alternatively, shareholders of poorly performing firms benefit most when an optimally optimistic successor replaces a sub-optimally optimistic incumbent.

This hypothesis posits that the market considers the relative optimality of the optimism of the successor and incumbent, along with prior firm performance, in its assessment of the change in firm value associated with the turnover. If shareholders attribute prior firm performance to the optimism of the incumbent CEO, we expect the greatest shareholder gains will accrue when a poorly performing firm replaces an over- or under-optimistic incumbent with a moderately optimistic successor. Relatedly, we expect the most negative market reaction to occur when a well-performing firm replaces a moderately optimistic CEO with an over- or under-optimistic successor.

Data

Our sample consists of 437 CEO turnover events between 1992 and 2005 for firms in the S&P 1500 *Execucomp* database, obtained following Campbell et al. (2011).[4] Turnover is voluntary if the CEO's departure was announced at least six months in advance, is driven by health reasons, the CEO is at least 60 years old, or the CEO takes a position at another firm. Turnovers are forced if the incumbent is less than 60 years old, fails to retain or gain a seat on the company's board of directors, has no reported health problems, and the firm fails to announce the departure at least six months in advance.[5] *Execucomp* provides data on CEO tenure and age. *Computstat* provides accounting and industry data for the year preceding the turnover event. We compute the market-to-book asset ratio for the turnover year. Cash flow for investment is defined as earnings before interest, taxes, depreciation and amortization. *RiskMetrics* provides data on director independence.

We measure CEO optimism following Campbell (2014). *Thompson's Financial Insider* database is used to compute measures of optimism. As previously described, we classify the optimism of both incumbent and successor using the same three measures used in the extant literature. *Net-buy* measures optimism using net stock purchases. *Net-buy opt* includes option transactions in addition to stock transactions and *Invest* measures optimism using industry-adjusted investment. The successor's optimism is computed using data subsequent to promotion to CEO.[6,7]

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[4] Tests in Campbell et al. (2011) include 1,687 observations. Our sample is smaller due to our additional data requirements. Specifically, we require the observations to have available information to calculate optimism for *both* the incumbent and successor (using all three measures of optimism), information on the successor's affiliation and data on board independence. This reduces our sample size to 437 turnover events, of which 273 are inside replacements with available turnover announcement dates.

[5] Our classification follows Parrino, (1997).

[6] Following Campbell (2014), the estimation period for our measures of optimism is from the date of hire through 2012.

[7] The three proxies for optimism show little difference in the proportions of CEOs classified as optimally optimistic. Specifically, *Net-buy*, *Net-buy opt*, and *Invest* classify 31 percent, 44 percent and 43 percent of the incumbent CEOs, respectively, as moderately optimistic.

We report summary statistics for our sample in Table 1. It is interesting to note that 25 percent of the incumbent CEOs experience forced turnovers whereas 94 percent of the successors are firm insiders. The average board of directors consists of 69 percent independent directors and 62 percent of firms in our sample have incumbent CEOs who outperformed their industry. Successors are typically not close to retirement, with only 12 percent over the age of 60.

Results

The Decision to Hire an Insider and the Optimism of Incumbent and Successor

We use seemingly unrelated regressions (SUR) to explore the decision to hire internally, as a function of the optimism of the incumbent and successor. We estimate two simultaneous bivariate Probit regressions (Maddala, 1983; Ljungqvist, Marston, and Wilhelm, 2009). The models are estimated to permit the internal hire and optimism decisions to be endogenously determined, as a function of the other. We control for other factors identified in the literature as affecting the decision to hire internally (*e.g.,* Campbell, 2014; Huson, Parrino, and Starks, 2001; Naveen, 2006; Billett, King and Mauer, 2007). Our controls include an indicator for disciplinary turnover, firm performance measures (industry-adjusted measures of operating ROA and stock returns), an indicator equal to one if the incumbent is over 60, the proportion of independent directors, free cash flow (the sum of total earnings before interest, taxes, depreciation and amortization, in thousands) and the market to book asset ratio as a measure of growth options. Industry homogeneity is proxied using the three-year Herfindahl asset index for 3-digit SIC matched firms.

Panel A of Table 2 shows the first set of three SUR models. These regressions model the likelihood of choosing an internal successor as a function of the level of optimism of the incumbent relative to the successor, where the dependent variable in these models is equal to one if the firm hires internally. Along with our controls, each model includes an indicator based on one of the three optimism proxies.

Boards hire moderately optimistic successors in 57 percent, 60 percent and 60 percent of turnover events using the *Net-buy*, *Net-buy opt* and *Invest*, respectively, as measures of optimism. For these same three optimism measures, the successor has the same level of optimism as the incumbent in 41 percent, 48 percent and 49 percent of the turnover events, respectively.

These indicators equal one when the incumbent and successor share the same level of optimism. Panel B of Table 2 presents the second set of SUR models. The dependent variable in the second set of models is equal to one if the successor shares the same level of optimism as the incumbent. In these models, we include an indicator equal to one if the firm hires internally, along with our controls.[8] In Table 2 and in all subsequent tables, *p*-values are reported in parentheses for two-tailed tests of the null hypothesis that the coefficient estimate does not differ from zero. Significance at the ten percent, five percent and one percent level is indicated by *, **, and ***, respectively.

The results in Panel A of Table 2 provide strong evidence that the decision to hire internally is a function of the decision to hire a successor with the same optimism level as the incumbent. The results are consistent for all three optimism measures. The results in Panel B indicate that, when the board seeks to maintain the status-quo in optimism, they will tend to hire internally. The results reported in Table 2 provide strong support for the notion that boards are more likely to promote an internal successor when she possesses the same level of optimism as the incumbent. Taken together, this evidence supports H1: boards consider optimism in their replacement decision and the likelihood of an internal hire increases when boards seek to maintain the status quo in optimism.[9]

Changes in Firm Value and the Optimism of Incumbent and Successor

We use standard event study methodology and *Eventus* to compute two-day cumulative abnormal stock returns around the announcement of CEO turnover for firms that select inside successors.[10] The two-day cumulative abnormal return (CAR) window includes the announcement date of the incumbent's departure and the following trading day. The CARs are computed using a one-factor market model

[8] We additionally control for the likelihood of replacing a moderately optimistic CEO with a moderately optimistic successor, as Campbell (2014) shows that boards learn more from past successes than failures.

[9] Although not reported in the paper, we investigate the same relations using two-stage least squares regressions that assume linearity in these decisions. This approach only allows for partial endogeneity in the decision-making process. The results are generally consistent with those reported here.

[10] Our sample is limited to inside hires for tests of changes in firm value around replacement announcements. Studies document heterogeneity in the timing of the market's recognition of the quality of inside and outside hires. Boards also tend to groom inside successors, and announce internal hires concurrent with incumbent departures.

and the value-weighted market index. Market model parameters are estimated using a 200-day period ending thirty days prior to the turnover announcement. Although our sample includes 410 instances of CEO turnover with internal successors, turnover announcement dates are only available for 273 of these observations.

We model the stock price reaction around CEO turnover announcements using median regressions to mitigate the influence of outliers. The first set of regressions tests H2, which contends that the change in firm value will be more positive (negative) when a successor is chosen who improves (worsens) CEO optimism. We model changes in optimism using four indicator variables reflecting whether the CEO's optimism improves, worsens, remains suboptimal or remains moderate. Columns 1 through 3 of Table 3 classify optimism using the three optimism proxies, *Net-buy, Net-buy opt* and *Invest*, respectively.[11] H2 predicts a positive coefficient when optimism *improves*, and a negative coefficient when optimism *worsens*. Our regressions additionally control for the quality of the incumbent using indicator variables if the firm's prior-year stock return exceeded that of the industry-average, as well as the industry-adjusted operating ROA in the year prior to turnover.[12] Further controls include indicator variables denoting whether the successor is over the age of 60, and whether the turnover was involuntary.

The regressions in Table 3 show that neither coefficient for our variables of interest (*improves* and *worsens*) is significant at conventional levels. Thus, we find little support for H2. To the contrary, the results indicate turnovers resulting in changes in the optimality of CEO optimism have no significant impact on the value of the firm.

[11] Specifically, *improves* is equal to one if the incumbent CEO is under- or over-optimistic and the replacement is moderately optimistic. *Worsens* (reflected in the model intercept) is equal to one if the incumbent CEO is moderately-optimistic and the replacement is over- or under-optimistic. *Both subopt* is equal to one if both the incumbent and replacement are over- or under-optimistic. *Both moderate* is equal to one if both the incumbent and replacement are moderately optimistic.

[12] Our results are quantitatively similar if we use continuous measures of industry-adjusted stock and accounting performance. Industry-matched firms are defined as those with the same three-digit SIC.

Changes in Firm Value and the Optimism of Incumbent and Successor, by Firm Performance

Next, we model changes in firm value as it relates to changes in CEO optimism and firm performance, considered together. We again use median regressions on the two-day CAR around the turnover announcement. First, we test H3a, which predicts that the stock price will react more positively when the incumbent and successor have disparate levels of optimism, particularly for underperforming firms. We assign separate indicator variables to firms that have industry-adjusted ROA in the prior year that is positive and to firms that have industry-adjusted ROA that is negative. We interact these variables with two additional indicators equal to one if the replacement has the same or a different level of optimism as the incumbent. We include these new indicator variables in our regressions, along with prior controls. We present our results in Table 4, where Columns 1 through 3 classify optimism using *Net-buy, Net-buy opt* and *Invest*, respectively.

The models in Table 4 provide strong support for H3a. For the *Net-buy* and *Invest* optimism measures, the models show that the CAR is between 140 and 160 basis points higher when the successor and incumbent have disparate levels of optimism and the firm is underperforming. For well-performing firms, using *Net-buy opt*, we find a 90 basis points higher stock price reaction when incumbent and successor have disparate levels of optimism. We also find evidence of a more negative market reaction when firms choose successors with the same level of optimism as the incumbent. For these firms, using the *Net-buy* optimism measure, the models indicate a 140-basis point lower CAR for underperforming firms. Interestingly, the results suggest that even well-performing firms can benefit from a change in CEO optimism. When well-performing firms choose internal successors with the same level of optimism as the incumbent, the *Net-buy opt* model indicates that the CAR is 150 basis points lower, on average. Taken together, for inside replacements, our results show that the board's propensity to maintain the status quo in optimism tends to be viewed negatively by the market, whereas the decision to hire an internal successor with a disparate level of optimism is viewed more positively, on average. Thus, our results support the contention that shareholders benefit from changes in the level of CEO optimism when firms hire internally, regardless of firm performance.

Our final set of models provide a test of H3b, which predicts that poorly performing firms can benefit most when a sub-optimally optimistic incumbent is replaced by a moderately optimistic

successor. H3b also predicts the greatest costs will accrue to shareholders when well-performing firms replace a moderately optimistic incumbent with an over- or under-optimistic successor. In these models, we employ the same indicators for over- and under-performing firms as defined previously, along with our three proxies for optimism. We interact the indicators with four additional indicator variables, capturing the following changes in optimism for incumbent and successor: (1) suboptimal incumbent and suboptimal successor ("both subopt"), (2) moderate incumbent and moderate successor ("both moderate"), (3) suboptimal incumbent and moderate successor ("improves"), and (4) moderate incumbent and suboptimal successor ("worsens"). We report the results of our models in Columns 1 through 3 of Table 5, using same controls as in Table 4.

The results of our models in Table 5 provide support for the predications of H3b in only one instance. That is, for the *Invest* optimism proxy (Column 3), well-performing firms with worsening levels of optimism exhibit CARs that are, on average, 190 basis points lower.[13] On the other hand, we find little support for the contention that poorly performing firms benefit from replacing a sub-optimally optimistic CEO with a moderately optimistic successor. Some models provide evidence suggesting that the replacement of a moderately optimistic incumbent with a successor who is likewise, optimally optimistic, is perceived negatively by the market.[14] Taken together, with few exceptions, our results suggest that the costs of maintaining the status-quo in optimism, even at optimal levels of optimism, outweigh the benefits of choosing an internal CEO replacement with a different economic outlook from that of her predecessor.

Robustness Tests

In robustness tests, we explore alternative CAR windows around the turnover announcements to examine whether our results are an artifact of our choice of event window. We re-estimate the results presented in Tables 3, 4 and 5 using CAR windows of (-3,3), (-2,2), (-1,1), (-1,0) as well as a one-day window for the date of the turnover

[13] This relation has marginal statistical significance, with a p-value of 0.08. It is important to recognize that, for this model, the stock price reaction is quantitatively similar for well-performing firms that retain moderate CEO optimism, differing by only 60 basis points.

[14] This result is suggested in Column 4 for well-performing firms, and in Column 5 for both well- and poorly performing firms, with a difference in CAR for these firms of -250, -210, and -210 basis points, respectively.

announcement (day 0). Although not reported in a table, we find little evidence that the optimism of the incumbent and/or successor affects firm value using these alternative windows. Additional robustness tests explore whether our performance indicators are better modeled using above or below-average industry-adjusted stock performance in place of accounting performance. As such, we re-estimate the regressions in Tables 4 and 5 using industry-adjusted stock returns in the place of the industry-adjusted ROA to define our performance indicators, and find results quantitatively similar to those previously reported.

Concluding Remarks

Extant research finds that moderate CEO optimism is shareholder-optimal, as some degree of optimism is required to overcome the inherent risk aversion of top-level managers (e.g., Giat et al., 2010; Campbell et al., 2011). The CEO succession literature documents the relative costs and merits of hiring an outside CEO successor (see, for instance, Berns and Klarner, 2017). Studies generally conclude that *external* hires are more willing to initiate needed strategic changes. However, external hires can lack firm-specific knowledge to successfully implement these changes (Zhang & Rajagopalan, 2010). We explore the relative merits of replacing a CEO with an *internal* successor who differs in her economic outlook and perspectives from that of the incumbent, as proxied by comparative levels of optimism of the CEO successor and incumbent. We propose that a successor who offers a different level of optimism from that of the incumbent will be viewed, by the market, as more likely to initiate needed strategic change while possessing the necessary background to successfully implement these changes. Further, we provide evidence on the relation between changes in firm value and changes in the optimality of CEO optimism, considered separately and in conjunction with prior firm performance.

Our evidence shows that boards are more likely to choose internal CEO successors when they share the same level of optimism as the incumbent. However, an examination of the stock price reactions to turnover announcements suggests that this choice is suboptimal. When firms are underperforming, we find cumulative abnormal returns (CARs) around turnover announcements ranging between 140 and 150 basis points higher when boards choose a disparately optimistic successor. Models also show that the CARs around turnover events are between 140 and 150 basis points lower when boards select a CEO successor who shares the level of optimism of the

incumbent. We find little evidence that improvement (or worsening) in the optimality of CEO optimism results in measurable gains or losses for shareholders, irrespective of the performance of the incumbent.

Our results have policy implications for boards of directors. Our findings suggest that shareholders can benefit from inside succession when boards select a replacement who offers a different perspective and economic outlook from that of the incumbent, even though boards are disinclined to select such an individual. Thus, if the hire of an external replacement is not feasible, choosing an insider can offer a reasonable alternative when the successor's level of optimism differs from that of the incumbent.

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Table 1: Summary Statistics

	Mean	Median	Std. Dev.
I (1 if Successor is an insider, 0 otherwise)	0.94	1.00	0.24
I (Forced Turnover)	0.25	0.00	0.43
Industry-Adjusted stock returns ($year_{-1}$)	0.11	0.06	0.32
I (Incumbent outperformed industry) ($year_{-1}$)	0.62	1.00	0.48
Industry-Adjusted ROA – Incumbent ($year_{-1}$)	0.07	0.04	0.12
I (Successor > 60)	0.12	0.00	0.32
Outside directors (%)	0.69	0.71	0.16
Industry Herfindahl index	0.15	0.11	0.14
Cash Flow (1000s) ($year_{-1}$)	1337.50	401.90	2799.53
Cash Flow (1000s) (year 0)	1131.63	339.25	2109.29
Market/Book Assets ($year_{-1}$)	2.0212	1.5635	1.3701
Market/Book Assets (year 0)	2.1803	1.5137	1.8378
Cumulative Abnormal Return (CAR 0, 1)	0.0018	0.0011	0.0660

Table 2: The Choice of Inside Hires and CEO Optimism

	(1) Net-buy	(2) Net-buy opt	(3) Invest
Panel A: Inside Hire			
I (Same opt)	1.5581***	1.6356***	1.8617***
	(0.00)	(0.00)	(0.00)
I (Forced turnover)	0.1174	0.1036	-0.0302
	(0.41)	(0.48)	(0.86)
Ind-Adj stock returns	-0.1804	-0.1190	-0.4839
(Incumbent) ($year_{-1}$)	(0.55)	(0.65)	(0.26)
I (Incumbent outperformed	-0.1679	0.0672	-0.0327
industry) ($year_{-1}$)	(0.32)	(0.67)	(0.88)
Ind-Adj operating ROA	1.0309	0.7736	1.4157**
($year_{-1}$)	(0.15)	(0.39)	(0.01)
I (Successor age > 60)	0.0540	0.0082	-0.0222
	(0.78)	(0.97)	(0.94)
Outside directors (%)	-0.2021	-0.2467	-0.6013
	(0.60)	(0.52)	(0.11)
Industry Herfindahl index	0.2786	0.1624	0.1156
	(0.53)	(0.74)	(0.59)
Market/Book Assets ($year_{-1}$)	0.0422	0.0656	0.0478
	(0.62)	(0.39)	(0.59)
Cash Flow ($year_{-1}$)	0.0000	0.0000	-0.0000
	(0.46)	(0.74)	(0.80)
Market/Book Assets ($year_0$)	-0.0152	-0.0474	0.0159
	(0.75)	(0.24)	(0.76)
Cash Flow($year_0$)	-0.0001	-0.0000	0.0000
	(0.35)	(0.67)	(0.78)
Intercept	0.5579*	0.4317	0.4420
	(0.08)	(0.18)	(0.18)
Panel B: Successor Has Same Optimism Level as Outgoing CEO			
I (Incumbent opt = mod)	0.8575***	0.9399***	0.6513***
	(0.00)	(0.00)	(0.00)
I (Inside Hire)	1.2990**	2.1403***	1.8800***
	(0.02)	(0.00)	(0.00)
I (Forced turnover)	-0.1671	-0.0486	0.0182
	(0.28)	(0.74)	(0.90)
Ind-Adj stock returns	-0.1551	0.1848	0.4302
(incumbent)	(0.69)	(0.63)	(0.35)
I (Incumbent outperformed	0.3570	-0.2288	0.0366
industry) ($year_{-1}$)	(0.18)	(0.30)	(0.89)
Ind-Adj operating ROA	-0.4314	-0.6435	-1.2252*
($year_{-1}$)	(0.57)	(0.33)	(0.06)
I (Successor age > 60)	-0.1903	0.1888	0.0723
	(0.48)	(0.42)	(0.80)
Outside directors (%)	-0.1155	0.5980	0.6766
	(0.84)	(0.17)	(0.19)
Market/Book Assets ($year_{-1}$)	-0.0126	0.0015	-0.0279
	(0.84)	(0.98)	(0.67)
Cash Flow ($year_{-1}$)	-0.0000	-0.0000	-0.0000
	(0.35)	(0.90)	(0.60)
Market/Book Assets ($year_0$)	-0.0250	0.0943*	-0.0302
	(0.71)	(0.07)	(0.63)
Cash flow($year_0$)	0.0002	0.0000	0.0000
	(0.18)	(0.91)	(0.61)
Inverse Mills Ratio	0.4750	-0.7838	-0.0221

	(0.52)	(0.13)	(0.98)
Intercept	-2.3062***	-1.9783***	-2.3536***
	(0.00)	(0.00)	(0.00)
N	437	437	437

Table 3: Firm Value and Optimism Optimality

Dependent Variable: CAR(0,1)	(1)	(2)	(3)
	Net-buy	Net-buy opt	Invest
Intercept (worsen)	0.0071	0.0082	-0.0040
	(0.35)	(0.25)	(0.56)
I (improves)	-0.0003	0.0016	0.0070
	(0.97)	(0.83)	(0.33)
I (both subopt)	-0.0022	-0.0073	0.0097
	(0.78)	(0.31)	(0.19)
I (both moderate)	-0.0140*	-0.0124*	0.0060
	(0.09)	(0.08)	(0.40)
I (Forced turnover)	-0.0002	-0.0044	-0.0017
	(0.96)	(0.37)	(0.74)
Ind-Adj stock returns ($year_{-1}$)	0.0324***	0.0290***	0.0234**
	(0.00)	(0.00)	(0.01)
I (Incumbent outperformed industry) ($year_{-1}$)	-0.0109**	-0.0074	-0.0067
	(0.04)	(0.18)	(0.26)
I (Successor age > 60)	0.0019	0.0024	0.0030
	(0.77)	(0.72)	(0.67)
N	273	273	273
Pseudo R-squared	0.0249	0.0295	0.0181

Table 4: Firm Value, Performance and a Simple Change in Optimism

Dependent Variable: CAR(0,1)	(1)	(2)	(3)
	Net-buy	Net-buy opt	Invest
Intercept (Diff opt & good perf)	0.001	0.009**	-0.001
	(0.83)	(0.03)	(0.86)
I (Same opt & good perf)	-0.007	-0.015***	0.004
	(0.14)	(0.00)	(0.38)
I (Diff opt & bad perf)	0.014**	0.001	0.016**
	(0.03)	(0.90)	(0.05)
I (Same opt & bad perf)	-0.014*	-0.004	0.007
	(0.07)	(0.56)	(0.31)
Control variables:			
I (Forced turnover)	0.0028	-0.004	-0.001
	(0.55)	(0.31)	(0.92)
Ind-Adj stock returns (Incumbent) ($year_{-1}$)	0.027***	0.023**	0.030***
	(0.00)	(0.01)	(0.00)
I (Incumbent outperformed Industry) ($year_{-1}$)	-0.005	-0.007	-0.009
	(0.39)	(0.13)	(0.12)
I (Successor age > 60)	0.002	0.003	0.004
	(0.78)	(0.61)	(0.60)
N	273	273	273
Pseudo R-square	0.032	0.037	0.021

Table 5: Firm Value, Performance and Optimism Optimality

Dependent Variable: CAR(0,1)	(1)	(2)	(3)
	Net-buy	Net-buy opt	Invest
Well-performing firms:			
I (both moderate)	-0.018	-0.021**	-0.013
	(0.11)	(0.05)	(0.19)
I (both subopt)	-0.012	-0.018	-0.011
	(0.25)	(0.10)	(0.29)
I (worsens)	-0.015	-0.015	-0.019*
	(0.30)	(0.23)	(0.08)
I (improves)	-0.009	-0.006	-0.014
	(0.40)	(0.62)	(0.16)
Poorly performing firms:			
I (both moderate)	-0.025*	-0.021*	-0.010
	(0.08)	(0.09)	(0.38)
I (both subopt)	0.012	0.015	0.015
	(0.23)	(0.13)	(0.10)
I (worsens)	0.011	-0.001	0.011
	(0.50)	(0.97)	(0.57)
I (improves)	-0.001	-0.009	-0.005
	(0.92)	(0.46)	(0.67)
Control variables:			
I (Forced turnover)	-0.001	-0.002	-0.004
	(0.896)	(0.669)	(0.446)
Ind-Adj stock returns	0.030***	0.029***	0.026***
(Incumbent) ($year_{-1}$)	(0.003)	(0.002)	(0.005)
I (Incumbent out-performed Industry) ($year_{-1}$)	-0.006	-0.006	-0.007
	(0.335)	(0.313)	(0.189)
I (Successor age > 60)	0.004	0.001	0.003
	(0.618)	(0.931)	(0.620)
N	273	273	273
Pseudo R-square	0.034	0.037	0.025

Hurricane Michael Impact on Bay County, Florida Home Prices

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Abstract

This paper expands the climate economics literature by determining the impact of Hurricane Michael on the Bay County, Florida home sales prices using an equilibrium displacement model. The results provide evidence of $35,584,042.60 of collective property value lost by homeowners. Under the assumption that governments provide relief of a quarter to a third of damages, $8,896,010.65 to $11,742,734.06 would need to be provided to remain consistent with past relief. Further, a 15 percent deadweight loss assumption yields $1,334,401.60 to $1,761,410.11 of that aid being lost. Policymakers can use this information in designing relief packages.

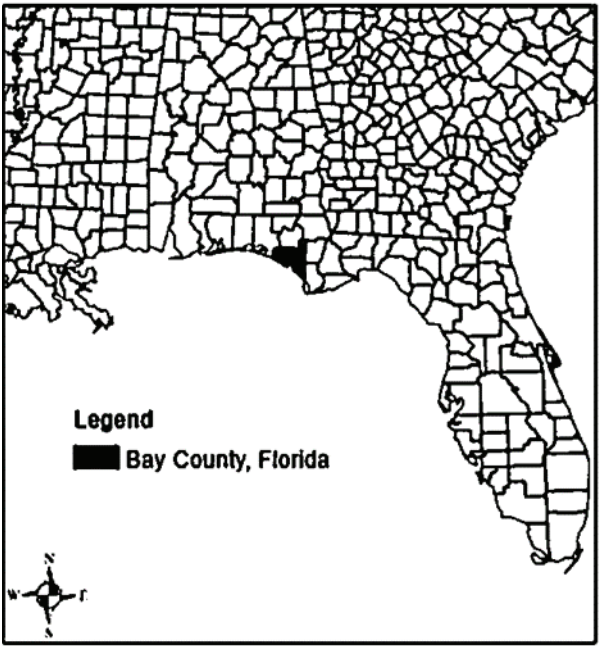
Introduction

Category 5 Hurricane Michael struck on October 10, 2018, shaking the southeastern United States. 51 people tragically lost their lives according to the National Weather Service, and in addition to insurmountable human toll, billions of dollars in damages swept across the Florida Panhandle, Alabama, and Georgia. The losses of timber alone in Florida are over $1.4 billion inclusive of estimated replanting costs. The estimated loss of timberland in Georgia was valued at $762,683,909. Further 50,000 structures in the Panhandle are estimated to have been affected, while 3,000 were estimated to have been destroyed. Deryugina (2017) finds that hurricanes in the United States have on average caused $8.1 billion of annual damages between 1970 and 2005. They also find that on average, higher wind speeds correspond nonlinearly with larger damages all else equal, which emphasizes the importance of examining Michael. The

objective of this paper is to estimate the economic impact of Hurricane Michael based on housing prices received during sale in Bay County, Florida before and after the disaster.

The cities of Callaway, Lynn Haven, Mexico Beach, Panama City, Panama City Beach, Parker, and Springfield are all in Bay County and represent the area that Michael first struck land. For perspective on the ferocious strength of the storm surge, NWS provides photography of two net inlets cut into the St. Joseph Peninsula State Park in Cape San Blas The largest storm surge was 9-14 feet from Mexico Beach to the town of Indian Pass. Flooding in Bay County was found to rise to a record near Ecofina Creek of 26.17 feet. Figure 1 shows the location of Bay County, Florida within the southeastern region of the United States.

Figure 1: Bay County, Florida, United States



Theoretical Framework

The following system of equations identifies the model:

(1) $D = Q_d(H, P), D_P < 0\ , D_H > 0$: Demand
(2) $S = Q_s(P), S_P = 0$: Supply
(3) $Q_d = Q_s$: Equilibrium

Equation (1) describes demand as a function of price and pre-hurricane weather. The demand curve is downward sloping indicating that it is a normal good. There is positive relationship between pre-hurricane weather and quantity demanded, thus assuming buyers lose utility from the natural disaster. Equation (2) indicates that supply is determined solely by price. The supply curve is fixed, illustrated by a vertical line. Equation (3) is a market-clearing non-goal equilibrium that states that consumers and producers will demand and supply the same quantity of houses.

The system above can be rewritten into equilibrium displacement model (EDM) form by expressing the variables in relative change terms using algebraic steps. The new system is:

(4) $Q_d^* = \eta_H H^* + \eta_P P^*$
(5) $Q_s^* = \varepsilon_P P^*$
(6) $Q_d^* = Q_s^*$

The asterisks indicate relative change ($Q_d^* = dQ_d/Q_d$). The structural elasticities η_P and ε_P are price elasticities of demand and supply, respectively. Furthermore, η_H is the hurricane elasticity of demand. To solve the reduced form equation with respect to price, substitute equations (4) and (5) into equation (6) to yield:

(7) $P^* = \frac{\eta_H}{\varepsilon_P - \eta_P} H^*$

Differentiating equation (7) with respect to pre-hurricane conditions produces an equilibrium displacement hypothesis that drives this paper:

(8) $\frac{\partial P^*}{\partial H^*} = \frac{\eta_H}{\varepsilon_P - \eta_P} > 0$

Assuming the supply curve is fixed ($\varepsilon_P = 0$) and that demand curve is downward sloping ($\eta_P < 0$), theory predicts that equilibrium price will increase because of pre-hurricane conditions all else equal. This hypothesis can be tested statistically.

Empirical Framework

Following the simplest specification of event study, the model to be identified is:

$$(9)\quad lnp_{ist} = \alpha + \lambda After_t + X'\beta + \varepsilon_{ist}$$

The dependent variable is the natural log of housing prices, X is a vector of household characteristics including sq. footage, natural log of landmark value, number of bedrooms, number of bathrooms, age in years and its quadratic, the number of letters within a street name, natural log of road frontage in feet, and tax district dummies. The estimated coefficient of lambda is the estimated impact of Hurricane Michael on average housing prices holding other characteristics constant. The null hypothesis that lambda is significantly different from zero and its rejection or failure to reject as well as its estimated sign will allow for evaluation of the equilibrium displacement hypothesis that nice weather positively impacts housing prices.

Data

Data was obtained from Bay County, Florida GIS Department's website. Table 1 presents the summary statistics.

Table 1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Price($)	2,888	215,093.88	175,098.02	9,757	2,247,900
Sq. Footage	2,888	1,665.06	632.59	256	7,152
Road-front	2,888	53.82	48.49	0	400
Landmark($)	2,888	43,915.28	48,527.76	3,216	690,000
Bedrooms	2,888	3.02	0.74	1	8
Bathrooms	2,888	2.12	0.63	1	7.5
Letters	2,888	7.85	3.04	1	21
Age	2,888	27.94	19.74	1	119

There are 2,888 observations in the sample. The mean home price is $215,093.88. The home prices range from $9,757 to $2,247,900. The average home size is 1,665.06 square feet with a range of 256 to 7,152. The average road-front exposure is 53.82 feet with a range of zero to 400. The average landmark value is $43,915.28 with a range of $3,216 to $690,000. The average number of bedrooms is 3.02 and ranges from 1 to 8. The average number of bathrooms is 2.12 and ranges from 1 to 7.5 The average age is 27.94 years and ranges from 1 to 119. 44.74 percent of the sample is in the post-Hurricane Michael period. The sample ranges from January 1, 2018 to June 14, 2019. Inflation is accounted for using a rate of 2.48 percent between 2018 and 2019. The measure of number of letters in a street-name is easily inferable from the street address provided in the dataset. The average address contains 7.85 letters and values range from 1 to 21.

Results and Discussion

Table 2 shows the results from pooled OLS estimation with individual-cluster robust standard errors of the model in Stata 15.

Table 2: Economic Impact of Hurricane Michael

	logp
impact	-0.137***
bedrooms	0.0236
bathrooms	0.100**
sqft	0.000324***
age	-0.0104***
agesq	0.0000574*
logroadfront	-0.00159***
loglandmark	0.384***
streetletters	0.0103*
1.taxdist	0
2.taxdist	0.0575
3.taxdist	0.00320
4.taxdist	-0.0105
5.taxdist	0.260***
6.taxdist	0.0785
7.taxdist	-0.160
8.taxdist	-0.116*
9.taxdist	0.216***

_cons	7.395***
N	2888
R^2	0.476

Standard errors clustered at individual level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Homes sold after Hurricane Michael on average received a 13.7 percent lower price than similar homes before the disaster all else equal. This result is statistically significant with a p-value less than .001. This provides support of the equilibrium displacement hypothesis that hurricanes negatively affect housing prices. The positive signs for bathrooms, bedrooms, sq. footage and landmark value make sense. Buyers may be willing to pay more for a home if they are in proximity to recreational amenities such as beaches, recreational parks, art galleries, or historic landmarks, etc. Cebula (2009) finds that homes located in the Savanna, GA Historic Landmark District on average sell at 20 to 21 percent higher prices than those outside. Ahlfeldt and Maennig (2010) contribute that houses in proximity to designated landmarks in Berlin, Germany sold at a premium. The negative sign for age coefficient makes intuitive sense. A contribution of this paper is the premium placed on additional letters within a street address. This could be interpreted as buyer preference for uniqueness in the event of a large, infrequent purchase. Pochepsova et al. (2010) find similar results and that consumers are willing to pay more for something perceived as rare, particularly in the case of spasmodic purchases, like homebuying. Argawal et al (2019) find that streets with fewer characters in their names sell for a discount and that buyers prefer homes on streets with “unique” or “disfluent” names in Sydney, Australia. The null hypothesis that the variables in the model are jointly insignificant is rejected with a p-value less than .001.

The increasing population in coastal areas combined with rising sea levels and in increase in the incidence of hurricanes provides the argument for increased public assistance planning. The increase in economic risk associated with these events incentivizes policymakers to be forward looking and allocate part of the social budget to this form of relief. Keen, Freeman, and Mani (2003) found that the costs associated with disaster relief are growing at a faster rate than GDP. They estimate that world GDP has increased by roughly 3.4 percent annually over their sample, while economic costs of disasters have

increased approximately 7.4 percent year-over-year. They also find that in addition to more frequent instances of natural disasters (hurricanes, floods, windstorms, and draughts), the ferocity of the occurrences increases due to a shifting climate. Other economic costs associated with natural disasters that are outside of the scope of this paper include the decrease in domestic ability to produce exportable goods.

Vigdor (2008) found that Katrina increased the long run cost of living in New Orleans. Ortergan and Taşpınar (2018) found that Hurricane Sandy had adverse impacts on the New York housing market, but that the penalty is shrinking over time. One shortcoming of this study is the limited time-period since Hurricane Michael and the inability to uncover such results. Graham and Hall (2001) study Hurricanes Fran, Bonnie, and Floyd and find that they all had negative impact on home values. Votsis and Perrels (2016) add that public disclosure of flood risk is associated with price drops. The hurricanes have similar perceived consequences to home buyers. Diao et al. (2017) find that infrastructure investment leads to increasing home values over time. This could be a policy recommendation and provide some relief to residents in the impacted area. Deryugina (2017) examine the effectiveness of public disaster assistance payments and their impacts on other forms of social securities. They find that the average per capita reception of public disaster relief is around $400-$425 for hurricanes at or above the Category 3 level in their sample. Also, they find that the average payment transfer covers about a quarter to one-third of hurricane related damages. Other studies can examine the impact of Hurricane Michael on the labor market, like Deryugina et al. (2018) has for Hurricane Katrina victims displaced to Houston and Kirchberger (2017).

The total economic impact is found by multiplying the mean sales price of homes post-Michael ($202,130.38) by the average estimated loss (multiplying it by 1.137) yields the counterfactual mean home value had Michael not occurred. This amounts to $229,822.24. Multiplying both numbers by the number of observed sales post-Michael (1,285) and taking the difference will yield an estimate of loss of economic value associated with Hurricane Michael in the Bay County housing market. The final calculation is $295,321,579.84 - $259,737,537.24 = $35,584,042.60 in loss of value.

Following Deryugina (2017), the estimated government transfer assistance would be between 25 percent to a third of loss, or $8,896,010.65 and $11,742,734.06 to remain consistent with historic disaster relief. This paper adopts the Deryugina (2011) 15 percent deadweight loss assumption and estimates $1,334,401.60 to $1,761,410.11 of this assistance being lost. They note that in the public finance literature it is common to use deadweight loss assumptions ranging from 12 to 30 percent following Ballard et al. (1992) and Feldstein (1999). These assumptions would correspond to ranges of deadweight losses from $1,067,521.28 to $1,409,128.09 for 12 percent and $2,668,803.20 to $3,522,820.22 for 30 percent. This loss can be recorded as a fiscal cost of hurricanes and contributes to this strand of literature.

Other possible policy considerations are described in Pollner (2001) who suggest: catastrophe bonds; contingent surplus notes; exchange traded catastrophe options; catastrophe equity puts; catastrophe swaps; and weather derivatives. These by natural are financial instruments that are designed for mitigating natural disaster risk.

Conclusion

The equilibrium displacement model hypothesis that hurricanes have a negative effect on housing prices is supported by rejecting the null hypothesis that hurricanes have no impact on average housing prices with a p-value of less than .001. The economic impact associated with Hurricane Michael has been reported to be in the billions of dollars and growing. The estimates from this paper contribute evidence for another $35,584,042.60 loss in economic value associated with home sales in Bay County, Florida.

To remain consistent with historical government assistance, $8,896,010.65 to $11,742,734 would need to be provided. Assuming a 15 percent deadweight loss yields $1,334,401.60 to $1,761,410.11 of this assistance being lost. This deadweight loss ties into the literature of fiscal costs associated with natural disasters. Deryugina (2017) warns of the moral hazard issue associated with this disaster

relief, noting that economic actors may consider these payments and over-buy houses in hurricane-risk areas. They further argue that disaster relief payments may induce business owners to substitute away from unemployment insurance to their workers, effectively receiving an operational subsidy. Keen, Freeman, and Mani (2003) also warn of the prevalence of the Samaritan's Dilemma regarding disaster relief payments. These hazards should be considered when designing natural disaster relief policy. Pollner (2001) suggests developing financial instruments to hedge against natural disaster risk: catastrophe bonds; contingent surplus notes; exchange traded catastrophe options; catastrophe equity puts; catastrophe swaps; and weather derivatives. These methods are outside the scope of this paper but provide an alternative policy vehicle to explore by researchers interested in the economic consequences of hurricanes or other natural disasters.

Similar studies can be conducted on hurricanes to assess their economic devastation. Further research can examine the distribution of housing prices in the periods following the disaster to see how the distribution of aid resources has been received This is motivated by Keen's, Freeman's, and Mani's (2003) signal that the lower segment of the income distribution is disproportionately more at risk to these natural disasters. A stochastic dominance analysis of the cumulative distribution functions (CDF's) of housing prices before and after the hurricane would allow for conclusions regarding aid distribution to be drawn. Further work can also examine the macroeconomic impacts of the hurricane, such as its impact on the amount of goods exported from the domestic country or the impact on the depreciation of the exchange rate.

Further research into the determinants of housing prices through a hedonic framework should include measures of street name fluency. This paper links economics and psychology literature concerned with buyer perceptions for rare purchases, finding that there is a statistically significant premium associated with increased uniqueness of a street name, measured by the number of letters is contained.

As mentioned before, a limitation of this paper is the short amount of time since Hurricane Michael. Evidence of long-run effects will appear over time, and the results in this paper should be interpreted as the lower-bound for damages attributed to the hurricane because more

houses have been sold since this analysis. This paper provides the foundation for further research into hurricanes and their economic consequences.

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