THE BOILED FROG IN ORGANIZATIONAL LEARNING:

SENSING, ADAPTING TO AND SURVIVING ENVIRONEMNTAL CHANGE

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ABSTRACT

Radical change in a firm's environment is often viewed as *discontinuous, i.e. old beliefs are suddenly invalidated.* We introduce the concept of *continuous radical change* by which old beliefs are rendered fallacious at an incremental pace. We theorize that incremental change can be as harmful as discontinuous change because it can remain undetected for too long by incumbent organizations. Specifically, we argue for a curvilinear relationship between the pace of environmental change and the organizational lifespan. We test our predictions using data from some 31,000 restaurants in the New York city Metropolitan area between the years 2007-2018. We use a fixed effects regression model to test for differences in the lifespan of restaurants located in areas of slow but radical gentrification versus those located in areas with accelerated and radical gentrification. We find support for an inverted U-shape between the pace of gentrification and restaurant lifespan. We explore whether this relationship is driven by differences in restaurants' adaptation behavior.

Keywords:

Discontinuous and continuous change; organizational learning; exploration / exploitation

Introduction

"There is a quasi-scientific fable that if you can get a frog to sit quietly in a saucepan of cold water, and if you then raise the temperature of the water very slowly and smoothly so that there is no moment marked to be the moment at which the frog should jump, he will never jump. He will get boiled" (Bateson 1979, p. 98)

Organizational survival is periodically challenged by exogenous environmental change, i.e. a shift in the organization's external reality which makes its current beliefs useless for identifying satisfactory solutions (March 1991). Thus, to survive, organizations must be able to sense the change in the environment and adapt (March 1991, Teece 2007). While some adapt to change and thrive, others perish. This heterogeneity in organizational responses to exogenous change has been attributed to differences in routines (Benner 2009), strategy (Hannan and Freeman 1984), leadership (Tushman and Romanelli 1985) and generally, the balance between exploration and exploitation (March 1991, Posen and Levinthal 2012). In this paper, we argue that characteristics of the external change itself widely determine organizational survival. Specifically, we propose that the pace of environmental change affects an organization's capability to sense, adapt to, and survive exogenous environmental change.

Various scholars have described the consequences of the inability to sense radical environmental changes (Anderson and Tushman 1990, Kaplan et al. 2003), while others have described the organization's ability to adapt, conditioned on having been able to sense the change (Keister 2002, Kiesler and Sproull 1982, Levinthal and March 1981). The ability to sense is an important antecedent of the adapting process, i.e. the ability to learn from experience about an environment that has changed. This ability depends on the pace of environmental change, i.e. whether the environment changes in a more continuous or a discontinuous manner. We argue that it is harder to sense continuous change for reasons analogous to our initial quote on the boiled frog, i.e. an organization's ability to sense continuous change is limited.

In developing our arguments, we draw on two strands of literature. First, we use arguments from the organizational learning and adaptation literature to flesh out the relationship between environmental change and sensing by experiential learning (Posen and Levinthal, 2012, Stieglitz et al. 2016). Second, we draw upon the literature on environmental change to examine the precipitousness of environmental change (Asgari et al. 2017, Maula et al. 2013 Tushman and Anderson 1986). Specifically, we define environmental change as more or less continuous or discontinuous. By borrowing arguments from the learning and adaptation literature and applying them to the change literature, we claim that sensing change by experiential learning implies the ability to differentiate a signal of change from mere noise (Levinthal and Posen 2007). Naturally, this may require a performance shortfall that exceeds the level of noise in a stable environment (Posen and Levinthal 2012). If change, however, occurs continuously, the performance shortfall would rarely exceed the level of noise at any particular time. Thus, we argue that continuous change may be as harmful as its discontinuous cousin, as continuous change often goes undetected.

We test this claim analyzing the lifespans of restaurants facing gentrification, i.e. the process of displacing older, poorer residents, by a more affluent group of middle class. Specifically, we analyze how the pace of gentrification affects a restaurant's operating duration. We find that both very a fast and very slow pace of gentrification is associated with a reduced life expectancy. For faster changing restaurant environments, we argue that a lower life expectancy stems from the inability to adapt on time. Conversely, for slowly changing restaurant environments, we theorize that a lower life expectancy stems from the inability to sense the change on time. This is because organizations experiencing a continuous performance decline face the difficulty of telling apart (i) an altered environment from (ii) random noise in an

unchanged environment. In the first instance, organizations would ignore the change, whereas in the second, organizations would unlearn old beliefs and start again. Consider, for example, a restaurant owner offering Bologna sandwiches. If she finds that fewer people are coming into her store this could be due to the fact that many regular customers happen to be on vacation or it could be because the neighborhood around her has changed such that its new inhabitants have less appreciation for cold cuts and demand different food choices like salad wraps. In the former case, waiting until customers return from vacation while leaving the menu unchanged will do the trick. In the latter case of a changed neighborhood, however, she would need to forget about Bologna sandwiches and learn a new dish like the aforementioned salad wraps.

Given that the main source of learning is performance feedback, organizations need to determine a threshold between actual performance and expected performance beyond which it would perceive a performance shortfall as a change. It may be feasible to determine such a threshold when the level of noise is low, and changes are sudden. When however, change is gradual, it is harder to detect change.

We primarily add to the literature on radical environmental change (Anderson and Tushman 1990, Sosa 2011, Tushman and Anderson 1986) by expanding the concept of radical environmental change beyond cases of discontinuous change. Indeed, we show that continuous change may alter the value of strategic choices at least as revolutionarily as discontinuous change. Continuous change may even be more harmful than discontinuous change because it could go unnoticed, which would thereby lead organizations to act on outdated beliefs and reduce the ability for future learning (Levinthal 1997) and ultimately, performance. Contrary to much of the change literature, however, we analyze the impact of exogenous environmental change as opposed to technological change brought about by one of the players (e.g. Benner

2010). We also contribute to the literature on organizational learning and adaptation by examining the capability to sense rather than just adapt to environmental change. While some recent work has looked at the sensing of change (Chakravarti et al. 2011, Green and Shapira 2018), a systematic analysis of conditions under which sensing is possible as well as an empirical test thereof, is absent from the literature.

Theory

In this section, we apply arguments from the literature on organizational learning and adaptation to the realm of radical environmental change. First, we try to parse out the relationship between the ability to sense change and environmental dynamism. We then use the insights on such relationship to differentiate between two types of radical environmental change (continuous and discontinuous) and flesh out the neglected perils of continuous radical change (in the simulation section, we explicate the sensing mechanism theorized upon in a simulation experiment).

Sensing change in the environment by experiential learning

Experiential learning leads to a better fit of an organization with its current environment. More experience lets organizations repeat strategies that are beneficial under current circumstances while discouraging the use of strategies that are less beneficial (Fang 2012, Levinthal 1997). As a consequence, however, organizations are less apt to perform well in a different context (Miles and Snow 1984). Thus, a lower performance can typically be expected when a fundamental shift in the environment goes unnoticed (Haveman 1992, Henderson 1993, Nickerson and Silverman 2003, Tushman and Romanelli 1985). To prevent this from happening, organizations engage in sensing (Kiesler and Sproull 1982). Sensing change in an organization's environment is thought to happen by contrasting a stimulus against some level of aspirations (Kiesler and Sproull 1982). In concrete terms, this means that an organization compares its current performance with its performance target, and detects a problem when the current performance is below the target (Cyert and March 1963). The perceived performance shortfall could then be attributed to factors internal or external to the organization such as to a radically changed environment (Siggelkow 2001). Both conceptual and experimental work have suggested that decision makers can only sense environmental change if the current performance deviates by some magnitude from their own beliefs about the environment (Chakravarti et al. 2011, Kiesler and Sproull 1982). The threshold for the difference between beliefs and state of the environment to trigger sensing differs across organizations. Beliefs about the environment in turn are formed by experiential learning. Learning takes place "by encoding inferences from history into routines that guide behavior" where routines refer to -among other things- the "structure of beliefs" (Levitt and March 1988, p. 320). This implies that learning is about forming beliefs about the value of solutions available to the organization. Beliefs are refined by continued experiential learning.

Thus, experiential learning is a prerequisite to sensing radical environmental change, because only when the organization holds narrow beliefs about what performance it can expect, can it reliably sense change from a sudden performance shortfall. Its ability to sense also depends on the threshold it sets to differentiate between noise and a signal for a changed environment: A low threshold will lead to noticing change more often but also to a greater rate of mistaking noise for change. Likewise, a high threshold will lead to noticing change less often but also to a lower rate of mistaking noise for change.

Limitations of the ability to sense change in the environment lie in the "signal-to-noise ratio (Green and Swets 1966, Kiesler and Sproull 1982, Peterson et al. 1954) where the signal is the performance shortfall due to change, and the noise is random variation in a solution's payoff in a stable environment. The more noise characterizes the environment, the harder it is to sense the genuine signal of change. This is so, because it is difficult for a decision maker to attribute a drop in performance to either radical environmental change or random noise in a stable environment. Beyond a level of noise equal to the signal of change, attempts of sensing is merely guesswork. Hence, it follows that, when the level of noise exceeds the amount by which the solution exploited by an organization decreases in value, an organization cannot sense the change in its environment.

Further, the ability to sense may be impaired by organizational memory loss, i.e. the fact that lessons from experiential learning (Argyris and Schon 1978) may not always be retained or may be forgotten over time (Haunschild et al. 2015, Walsh and Ungson 1991).

Unlearning in response to sensing environmental change

Sensing in itself is not easy to identify, because we cannot access the mental representation decision makers have of their environment (Green and Shapira 2018, Teece 2007). Prior

research, however, suggests that often times sensing is accompanied by a distinct change in learning behavior: unlearning, which allows for the subsequent relearning of old beliefs. This is so because the same experiential learning that makes possible the sensing of change also hinders relearning of the value of old solutions in the changed environment. Previous work has proposed that outdated beliefs may be a threat to adaptation in the changed environment (Levinthal 1997) and may best be erased from the organization's memory, i.e. unlearned (Starbuck 2017). In sum, when radical change is identified, unlearning of old beliefs appears to be the best way to deal with the altered environment as otherwise the burden of inaccurate beliefs would hinder adaptation to the new environment (Asmussen et al. 2016, Cirillo et al. 2014, Holan and Phillips 2004, Kim 1998, Starbuck and Hedberg 1977). Hence, "changing situations" require, among other things, the "unlearning of prior premises" (Garud et al. 1997, p. 298). Overall, an organization will set a threshold between expected performance and observed performance based on the level of noise at which its performance usually varies. When an organization experiences a drop in performance exceeding this threshold, the organization will attempt to unlearn old beliefs.

Types of radical environmental change

Fatal disruptions, arising in an incumbent organization's environment, are commonly linked to discontinuous change (Tushman and Anderson 1986) or even equated with radical change (Tushman and O'Reilly 1996). These forms of radical change are seen as competence destroying and believed to alter the values attached to a firm's set of choices dramatically and instantaneously (Tushman and Anderson 1986). Overall, the attribute often highlighted about radical environmental change is its suddenness (Tushman and Anderson 1986). This means the change is assumed to take place in a rather short period of time (Asgari et al. 2017, Maula et al.

2013). This aspect is also reflected in the fact that the change is often referred to as a *discontinuity* (e.g. Sosa 2011).

Meanwhile, radical change that happens continuously is not often considered. In Bateson's (1979) boiled frog analogy, he explains that if you were to put a frog in boiling water, it would sense the danger and jump put. However, if you were to place it in colder water and then gradually turn up the heat, it would not be able to sense the threat and die. Likewise, an organization for which the environment is changing completely but over an extended period of time would remain unaware of the radical change and not be able to adapt to the new situation in time. We accordingly define *continuous radical change* as change that alters the valuations of all the solutions available to an organization completely, but which happens over an extended period of time. There are many recent examples of situations where radical change took place in a continuous way. For example, the US postal services lost most of their mail business to electronic mail providers over a period of the last 20 years while the losses only started to exceed self-set performance targets since 2011 (Pociask 2016). This resulted in a radically changed situation for them that, however, did not happen right after the new email technology arrived. Another example can be found among firms in the grocery industry, where consumer preferences have radically shifted from home cooked to prepared meals (Yoon 2017). This change has taken place over the course of almost 50 years. To our baseline argument above, this type of change clearly provides a challenge: Even for moderate levels of uncertainty it is hard to discern radical change from environmental noise if the change is taking places in such incremental steps. Hence, we propose

Hypothesis 1. When an organization experiences continuous radical change, sensing becomes more challenging even for low levels of noise. Therefore, the more continuous the nature of the change, the slower an organization will unlearn.

Implications for organizational survival

Prior research has often linked threats to an organization's survival with the failure to sense radical environmental changes (Siggelkow 2001, Tripsas and Gavetti 2000). This line of reasoning is as follows: Organizations that fail to sense change in their environment act on outdated beliefs (Levinthal 1997). From engaging in learning about the environment prior to the change, the organization has learned to pursue solutions that had proven to be profitable while ignoring others that had proven to be unprofitable (Denrell and March 2001). Once the environment has changed, however, the previously profitable solutions may now be inferior while the previously unprofitable solutions might earn the organizations great profits. Acting on outdated beliefs thus means consistently realizing inferior profits by exploiting the wrong solutions. Consistent under-performing relative to those organizations that do sense change, however, leads to a higher likelihood of demise (Klepper 2002). It follows that

Hypothesis 2. An organization experiencing continuous radical change will have lowered survival chances all else being equal.

At the same time, discontinuous environmental change may also be associated with lower organizational chances of survival. An immediately altered environment makes timely implementation of new solutions necessary (Benner 2010). In particular, it means replacing old solutions with new solutions. Since organizations tend to get inert in their ways over time, they often fail in replacing old solutions with new ones in time (Sosa 2011). As more continuous change as well as sudden, discontinuous change results in lower survival chances, we argue that

Hypothesis 3. There will be an inverted U-shape between the pace of environmental change and organizational survival.

Gentrification as environmental change

The Merriam-Webster dictionary introduces gentrification as the "the process of repairing and rebuilding homes and businesses in a deteriorating area (such as an urban neighborhood) accompanied by an influx of middle-class or affluent people and that often results in the displacement of earlier, usually poorer residents". In New York, gentrification is also called "brownstoning" as it started by members of the middle class buying and renovating old brownstone houses in poorer neighborhoods. The process of gentrification often follows the same steps. To first qualify for later gentrification, richer inhabitants need to trade in their homes in a formerly affluent neighborhood for suburban homes. The abandoned neighborhood attracts low income residents involving a decrease in investments and a decrease of the quality of neighborhood infrastructure. When now inner city living becomes more attractive and house prices are low, gentrification sets in. At first, middle class residents buy homes in the run-down neighborhood which they renovate themselves. Those early stage gentrifiers are not primarily driven by the potential increase in house prices but rather by living in an urban community and by the historic value of the houses they are buying. This type of home ownership is also called sweat equity. As a consequence of the efforts of the first wave of gentrifiers, quality of life improves in their communities and others start noticing the potential for real estate in gentrifying neighborhoods as an investment. In a second step, investors start buying real estate and market it to wealthy buyers. At the same time, businesses which are catering to the new tenants start pouring in, for example, vegan restaurants, bars, or Starbucks cafes. To make room for wealthier tenants, investors also engage in active displacement, i.e. they try to evict poorer members of the community to be able to renovate and sell properties to a more affluent group of tenants.

In sum, the process of gentrification is characterized by an increase in home prices, evictions of poorer tenants and an influx of bars and cafes catering to the new middle class.

Take, for example, the history of the Mott Haven neighborhood in the South Bronx. After Jordan Mott's ironworks had set up shop in the 19th century, rows of brownstone houses were constructed in the present-day Mott Haven historic District to house the managerial elite. This process aided by commuter trains beginning to service the Bronx. Post-World War II, following an influx of Puerto Rican immigrants and a greater accessibility of the suburbs by highways, many of the white residents moved out of Mott Haven and into the suburbs. From the 1970s onwards, Mott Haven was ridden with gang violence, poverty and poor living conditions. In recent years, however, gentrification has taken hold of Mott Haven. First, local investments and efforts turned vacant spaces into community gardens and low-income co-ops. Next, investors bought waterfront property and developed them into luxury lofts. The investment in housing is met also with an increase in fancy coffee shops, bars and other businesses. At the same time, eviction rates are increasing - proof of the ongoing displacement of low-income tenants.

Method

Context

The restaurant industry is ideal to test the effect of radical environmental change on organizational performance because it provides a sizable sample with a large variance of firm survival rates as well as a frequently changing environment by virtue of demographically changing city neighborhoods (Kalnins et al. 2006). Specifically, as survival rates vary greatly across organizations, restaurants offer the unique advantage of providing large number of organizations exposed to the same environmental changes. Further, restaurants usually have shorter lifespans than other types of organizations making the necessary time window shorter (Hannan and Freeman 1983). The setting also constitutes one of the most important industries in

the US and in New York City. Nationwide, restaurant sales gross at around 785 billion US dollars while food establishments employ around 10 percent of the country's workforce. In New York City alone, eateries sell food worth around 43 billion US dollars and employ more than 800,000 people1.

Data

The first source of data is the permit database of the New York City Department of Health and Mental Hygiene (DOHMH). It contains information on when an operating permit (Food Service Establishment Permits) was first granted and when a permit ultimately expired. Such permits are a necessary prerequisite to operating any business in New York City that serves food. Thus, it gives an accurate overview of the lifespan of restaurants in New York City. The cleaned data set contains 30,392 entities. In each given year, there were between 10,000 and 14,000 restaurants active (Figure 1), most of them located in Manhattan (Figure 2). The earliest permit in the data was granted July 2007 and the last one in August 2018. The average time a restaurant was in business is 662 days. The DOHMH data set further contains information on cuisine type, permit violations, owner, and exact location of the restaurant. In the following, we leverage this location information to assign each restaurant to a gentrification rate in its neighborhood.

----------Insert Figure 1 here----------

----------Insert Figure 2 here----------

We use different data to approximate the pace of gentrification. First, we use evictions. We extract data on the number of evictions filings for each New York neighborhood from data provided by the NYC Department of Investigation. Eviction filings are closely associated with gentrification as landlords have an incentive to replace space for poorer tenants with offers catered to incoming richer tenants. Secondly, we use the entry rate of new cafes and bars into a given neighborhood to approximate gentrification. The influx of cafes and bars has been shown

to be a hallmark of gentrification (Glaeser et al. 2018). We estimate entry rates of cafes and bars using the same data from the DOHMH which contains additional details on the type of a restaurant which allows us to distinguish cafes and bars from other types of eateries.

We use data from the Federal Housing Finance Agency as well as zillow.com on the development of home prices. We are particularly interested in the 10-year annualized home value index. The agency's house price index is based on the development of single-family house price per year and is a "weighted, repeat-sales index, meaning that it measures average price changes in repeat sales or re-financings on the same properties" (*Federal Housing Finance Agency*, 2018). The Zillow index is based on a machine learning estimate of all home values in a zip code sold or not. We use the FHFA index as a control.

Additionally, we collected data on changes in restaurants' menus during our observation period from 2007 to 2018. Concretely, we collected menu texts from restaurant websites and yelp.com. We then used the *wayback machine* to find older versions of the same menu and compare the texts to see to what degree it had changed. All in all, we gather information on 1395 restaurants in this way. The distribution of change rates is depicted in Figure 3.

----------Insert Figure 3 here----------

Estimation

To test whether very slow and very fast environmental change have more negative performance effects than change rates in between the extremes, we run a simple OLS model with fixed effects for the type of restaurant cuisine. The results are robust to other estimations such as a propensity score matching. We exclude extraordinarily high values of evictions as those will likely be the consequence of a high poverty neighborhood as opposed to gentrification (Desmond and Gershenson 2017).

Dependent variable

The dependent variable is the restaurant lifespan. The information for this variable was extracted using the DOHMH operating permits. Lifespan is measured in days of having an operating permit.

Independent variables

The central independent variable is the entry rate of new bars. The information was taken from the same DOHMH database counting the number of new bars entries over the observation window from December 2007 to April 2018. In the same way, we used the entry rate of new cafés as a secondary explanatory variable. Lastly, we used the rate of eviction filings as another way to approximate the pace of gentrification. In particular, we used the average number of evictions filed per year for each neighborhood. The information was taken from the New York City Marshals. The entry of new cafes or bars is a good indicator of gentrification as this type of businesses is typically associated with an influx of a younger, more affluent demographic (Glaeser et al. 2018). The eviction filings measure the other side of the same coin, i.e. the displacement of poorer residents (Lee 2003).

Control variables

We control for the number of employees as a proxy for firm size. Further, we control for changes in rent prices. The latter is important to separate effects driven by a change in the exogenous environment - i.e. the customer base has changed - from a change in costs. Through including cuisine fixed effects we also exclude that effects are driven by cuisine specific trends.

Results

The effect of gentrification pace on restaurant lifespan

To find the effect of gentrification pace on restaurant lifespan, we regress lifespan – i.e. how many days a restaurant survived for - on the entry rate of new bars (see Table 4-1, model (1)). It is important to note that we consider only restaurant lifespans for restaurants that are not bars to

avoid including the same observations in both the left and the right-hand sight of the regression equation. We further exclude neighborhoods with an entry rate of less than 1 bars per year this would not constitute radical change. Since we hypothesized the effect to take the form of an inverted U-shape, we include also the squared effect of the entry rate. In line with our argument we find that the coefficient for entry rate is positive and significant ($p = 0.035$) while the coefficient for the squared term is negative and significant ($p = 0.035$). We plot the curvilinear effect in Figure 4. The effects also hold when using the entry of cafes rather than the entry of bars. Besides our main effect, both restaurant size ($p < 0.000$) and change in rental prices ($p = 0.004$) have a positive and significant effect on restaurant lifespan.

----------Insert Table 1 here----------

----------Insert Figure 4 here----------

Robustness check: entry of cafes as a measure of gentrification

As an additional check, we conduct the same analysis with the entry of new cafes rather than bars (see Table 1, model (2)). Results are consistent with findings using the entry of bars. The coefficient associated with the entry rate of cafes is positive and significant ($p = 0.024$) while the coefficient associated with the quadratic term is negative and significant ($p = 0.011$). Notably, an increase in rent prices is no longer significantly associated with a change in restaurant lifespan. The inverted U-shape is depicted in Figure 5.

----------Insert Figure 5 here----------

Robustness check: eviction filings as a measure of gentrification

We repeat the analysis by replacing the independent variable with the number of eviction filings (see Table 1, model (3)). Coefficients take the same direction as with the entry rates of cafes. There is a positive effect of eviction filings on restaurant lifespan and a negative effect of the squared term. However, neither the effect of filings ($p = 0.137$) nor the effect of the square term

(p = 0.292) become as significant as the effects of entry rates. We plot the inverted U-shaped relationship between eviction filings and restaurant longevity in Figure 6.

----------Insert Figure 6 here----------

Robustness check: repeating the analysis with only those restaurants founded in the observation window

To check that the effects were not driven by events in the history of the restaurants prior to our observation period, we repeated the main analysis leaving out those restaurants that were founded prior to December 2007. The main curvilinear effect of gentrification pace on restaurant lifespan remains unchanged. In particular, the coefficient for entry rates (of new bars) is positive and significant (p = 0.044) and the coefficient of its squared term is negative and significant (p = 0.034). The effect size is stronger than when leaving all restaurants independent of their founding date in the observations. Results are shown in Table 1a. In line with our argument we find that the coefficient for entry rate is positive and significant (p = 0.035) while the coefficient for the squared term is negative and significant (p = 0.035).

----------Insert Table 1a here----------

Alternative explanation: the effect of fast gentrification on lifespan is driven by increased competition

One could argue that the hypothesized inverted U-shaped relationship between pace of gentrification and restaurant lifespan is driven by increased competition for fast gentrification and poverty in neighborhoods of slow gentrification. Following this logic, fast gentrification brings about more competitors and thus it is not timely adaptation but dealing with increased competition which drives reduced lifespans. Effectively this would mean that competition would mediate the relationship between pace and lifespan. In a first step, for that to be true, gentrification pace would need to predict the level of competition. To test this, we construct

competition as a density measure capturing the number of restaurants in a given neighborhood per 1,000 inhabitants. We then regress the level of competition on entry rates of new bars. This yields a positive and significant effect suggesting that competition actually may work through the gentrification rate. However, to truly mediate the effect of entry rate on lifespan, the former effect would have to subside when including both terms into the regression. But, the effect of entry rate on lifespan stays highly significant ($p = 0.007$).

Alternative explanation: the effect of slow gentrification on lifespan is driven by particularly poor neighborhoods

Following the same logic, slow gentrification may not drive reduced lifespans through a lack of sensing but in fact through high poverty which just does not generate enough of a market for entering restaurants. In practical terms, this would imply that the effect of gentrification on lifespan is driven by poverty. We therefore use the NYC.gov poverty index (i.e. what percentage of the population lives below the poverty threshold of ~$33k a year). Again, we find no support that the effect of pace of gentrification becomes any weaker once a measure of poverty is included into the regression ($p = 0.009$).

Mediation analysis: How the inverted U-shaped relationship is driven by changes in adaptation

As previously discussed, we operationalize restaurant adaptation by changes in menus. In particular, we want to know if the degree of changes in menus mediates the effect of gentrification on restaurant lifespan. Results of the mediation analysis can be found in Table 2. We follow the mediation approach suggested by Barron and Kenny (1986). If adaptation truly mediates the relationship between gentrification pace and restaurant lifespan, we would expect to see a significant effect of gentrification pace (here: entry rates of bars) on restaurant lifespan

which we do observe (Table 2, model (1)). Further, we would expect to see a significant and positive effect of gentrification pace on menu changes where instead we find an insignificant effect (Table 2, model (2)). Lastly, we would expect the effect of gentrification pace on lifespan to become insignificant once the adaptation variable is included as an additional explanatory variable which we do find (Table 2, model (3)). Thus, overall we find limited support for a mediating effect of adaptation.

----------Insert Table 2 here----------

Survival Analysis

Additional data

A second source of data is Census data. From the US Census Bureau, we extract household income data necessary to construct our gentrification measure. In particular, we were interested at the median household income in New York for the beginning of our observation period in 2007. Additional income data is collected from the American Community Survey (ACS) which contains information on zip code level household income data for the aggregate period of 2006-2010.

Operationalization

The dependent variable is the duration of a restaurant's stay in business or its age. The main independent variable is the change rate in a restaurant's zip code. The change rate is operationalized by the gentrification rate. This gentrification rate we construct following an established method to measure gentrification (e.g. Herrine et al. 2016). In particular, we consider a zip code gentrified if (i) by the beginning of our observation period the average household income was in the bottom 40% of the city, and (ii) over the entire observation period, the home values increased by an above median amount. Note, that we observe different rates of increasing

home values which we take as a measure for different degrees of continuous change. We are left with 13 gentrifying neighborhoods.

Results

In a first step, we gather evidence consistent with our claim that continuous radical change can be more harmful to organizational survival than discontinuous radical change. To do so, we compare survival chances of restaurants in faster versus slower gentrifying neighborhoods. Since we have a substantial amount of right censored observations in our data, i.e. restaurants still in business at the end of our observation period, event history analysis is the appropriate method for our empirical test (Park and Russo 1996). The event on record is the case of a restaurant losing its operating permit.

We use a parametric hazard rate model and in particular a piecewise exponential model that allows for different hazard rates for different time periods (Blossfeld et al. 1989).

$r(t) = \exp(\alpha i + A * \alpha i)$,

where α will be estimated, A is the matrix of covariates and α i i s the constant element in period *i* . Utilizing the official home price index of the FHFA as a proxy for change rates, we compute a binary variable reflecting whether a restaurant is in a neighborhood which is changing faster than the median gentrification rate or slower than the median gentrification rate. In Figure 7, we plot the survival rates for restaurants in slow versus fast gentrifying neighborhoods. Restaurants in neighborhoods that gentrifying at a slower rate have lower survival chances. To test the significance of the difference in survival chances, we use a G-Rho test and find that a restaurant in a slowly changing neighborhood can be expected to survive more than a 100 days less than a restaurant in a fast changing neighborhood ($p < 0.001$). We show the test results in Table 3.

----------Insert Figure 7 here----------

----------Insert Table 3 here----------

Similar results can be found for the analysis of relatively declining rather than gentrifying neighborhoods (Figure 8).

----------Insert Figure 8 here----------

The results from the survival analysis do not contradict the predictions of the simulation analysis but they do not show the mechanism of sensing and subsequent adaptation behavior as a cause of differences in organizational survival. To establish that firms' adaptation behavior indeed accounts for differences in survival, we analyze changes in restaurants' menus. We make use of the mediation framework of Barron and Kenny (1986). In first step, we thus regress survival chances on the gentrification rate to show that gentrification does drive restaurant survival. As expected, we find that a higher gentrification rate is associated with a lower likelihood of restaurant death (Table 4, model (1)). In other words, a slower change rate implies a shorter life expectancy.

In a second step, we regress the mediator (the change in restaurant menus) on the gentrification rate. We find no significant effect (Table 4, model (2)). Next, we regress menu restaurant survival on menu changes (Table 5, model (3)). We find that the more the menu changes, the less likely the restaurant is to vanish ($p=0.1$). This, too, is in line with our argument that it is a lack of adaptation that harms firm survival chances.

Lastly, we regress restaurant survival on both gentrification rate and menu change rate (Table 4, model (4)). Both variables negatively impact the likelihood of restaurant death. The effect of gentrification is now weaker than in our first regression albeit still highly significant ($p=0.001$). The effect of menu changes is weakly significant ($p=0.09$). In conclusion, the mediation analysis suggests that there is limited evidence for a mediating effect of changes in menus. We argue, however, that such limited support is to be expected due to (1) a small sample size and (2) the fact that changing menus is only one of several possible measures of adaptation.

----------Insert Table 4 here----------

Discussion

Conclusion

In the analysis presented here, we show that organizations may suffer from both very slow and very fast exogenous change in their environment. While very fast change may make it impossible to adapt on time, very slow change may make it difficult to sense that the change is happening in the first place. We have presented evidence that this is true for restaurants in New York City experiencing gentrification.

Contributions to existing literature

Our primary contribution is to the literature on radical environmental change (Anderson and Tushman 1990, Sosa 2011, Tushman and Anderson 1986). While most prior work has focused on discontinuous change, we point to the fact that disruptions sometimes take a long time to manifest. When they do -a scenario we call continuous radical change- organizations may be harmed even more than when change is fast as it goes unnoticed for too long to react to it on time. This adds to literature on environmental change in two ways. First, we answer the call of Tushman and Anderson (1986) to study the patterns of change. We find that in particular the pace of change plays a crucial role in the performance implications of environmental change for incumbent firms. Further, while prior work has focused on innovation as a source of change, we study changing demand in a market of many small players as opposed to an oligopoly situation of few big players that endogenously bring about change. This applies to many other contexts for example in the service industry that have not been covered by prior work.

Further, our findings speak to the debate on organizational learning and adaptation. Much of prior work and learning and adaptation has looked at radical environmental change. For

example, Posen and Levinthal (2012) model environmental change and conclude that adaptation sometimes means to exploit known solutions because befits from learning cannot be accrued as fast as they diminish as the environment is changing again. Relatedly, Benner (2009) emphasizes that routines must be adapted to fit changing environments. Overall, most prior studies take a normative approach to adaptation in changing environments, i.e. they model how optimal adaptation should look like. On the contrary, we emphasize under which condition adaptation is possible. Specifically, we argued that adaptation can only take place when organizations sense the change in their environments which in turn depends on the pace at which the environment is changing. This adds to recent work on conditions under which sensing is feasible (Chakravarti et al. 2011, Green and Shapira 2018).

By extension, we also address the dynamic capability literature. Teece (2007) argued that dynamic capabilities, i.e. the capability to continuously update an organization's core of assets to meet the current environment's requirements, consist of (a) sensing and (b) seizing opportunities. Subsequent work, however, has focused on the seizing, i.e. the creation or altering of organizational resources (e.g. Helfat et al. 2007). Our findings draw attention to the sensing part of dynamic capabilities and suggest that no changes in an organization's resource endowment can be made without first accurately sensing the environmental change.

Lastly, we also add to the debate on which types of organizations are more likely to survive what kind of environmental change originating in theories of population ecology. For example, Hannan and Freeman (1983) distinguished between specialist and generalist organizations. We, on the contrary, focus on the pace of change as a factor for organizational survival and conclude that survival chances might be following a pattern of an inverted U-shaped such that survival chances are lowest in very fast and very slow changing environments.

Limitations

Despite its contributions, this study has a number of limitations. First, we purposefully study a situation where change is exogenous to the firm. Often times, however, change may be endogenously induced by one of the big players in an industry. In such an industry with few big players, we may observe that change is induced from fewer directions making it easier to sense. Further, vicarious learning is not central to our model but may be more important in more concentrated industries. Prior behavioral work has uncovered that organizational decision makers belonging to the group of "reciprocators", i.e. those that respond primarily to social norms, may sense environmental change much faster because they sample from more than just their own organization's experience (Bridoux et al. 2017).

Another limitation is the lack of a direct measure of sensing. Sensing -an inherently cognitive construct- can be approximated by observed behavior such as unlearning or adaptation but is hard to observe directly. We also have a limited amount of data on the adaptation behavior of restaurants. Further studies should explore to study the boiled frog phenomenon in other contexts with a greater availability of adaptation data.

Lastly, critics may argue that out findings are conditional on the fact that change indeed does happen. In a world, where change often times does not manifest, decision makers may be perfectly rational in not acting on slow environmental changes because most times, small changes do not end up leading to a major change in the environment. Given this, we are not arguing that the restaurant managers in our sample are necessarily acting irrational. What we do argue is that *when* radical change is taking place, a slowly changing environment may be as harmful and in fact, more harmful than sudden radical change.

Future research

It is hoped that our finding will serve as a starting point for more empirical research which tests the causal chain of environmental change, sensing and adaptation. In particular, more work is needed on measuring the process of adaptation in the face of very slow and fast changing environments. One way to measure adaptation in exogenously changing environments would be to use patent data and the advent of new subclasses. New subclasses emerge frequently and grow at various rates. Growth could be measured by citations per subclass while a firm patenting in that subclass could represent adaptation. However, neither this nor our approach captures actual sensing. For that, more qualitative work is required.

Another interesting avenue for future research is to study which types of organizations fall prey to the boiled frog effect. Recent work has made headway into this by exploring the role different hierarchies play in sensing (Green and Shapira 2018). Future work could ask specifically what governance type is more or less likely to be the boiled frog.

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	DV: Lifespan		
Variable	*(1)*	*(2)*	*(3)*
Entry Rate Bars	20.31** (7.86)		
Entry Rate Bars²	-0.24** (2.18)		
Entry Rate Cafes		10.28 (9.09)	
Entry Rate Cafes²		-0.11 (0.10)	
Avg. Evict. Filings p.a.			3.66* (1.75)
Avg. Evict. Filings p.a.²			-0.005. (0.003)
Size (# staff)	20.81*** (0.91)	20.95*** (0.77)	14.74*** (1.22)
ΔRent Prices	2284.00** (812.73)	100.10 (1000.18)	9346.70** (848.97)
Fixed Effects	<included>	<included>	<included>
R^2	0.15	0.15	0.09
Adj. R^2	0.13	0.14	0.05
*Note: *p<0.05, **p<0.01, ***p=0.001*			
Standard errors in parentheses			

Table 1: Gentrification and Restaurant Lifespan

	DV: Lifespan
Variable	*(1)*
Entry Rate Bars	43.93*
	(21.80)
Entry Rate Bars²	-0.70*
	(0.33)
Size (# staff)	16.17***
	(1.04)
ΔRent Prices	714.79
	(812.73)
Fixed Effects	<included>
R^2	0.11
Adj. R^2	0.08

*Note: *p<0.05, **p<0.01, ***p=0.001*
Standard errors in parentheses

Table 1a: Gentrification and Restaurant Lifespan

	DV: Lifespan	*DV: Menu Changes*	*DV: Lifespan*
Variable	*(1)*	*(2)*	*(3)*
Entry Rate	-3.29**	-0.002	-9.29
	(0.10)	(0.002)	(7.87)
Menu Changes			-52.97
			(874.41)

Table 2: Mediation Analysis (Lifespan and Adaptation)

	N	*Observed*	*Expected*	*(0-E)^2/E*	*(0-E)^2/V*
Fast Gentrification	1321	776	885	13.4	28.9
Slow Gentrification	1311	878	769	15.4	28.9
Chi^2	28.9				
Df	1				
p	0.00				

Table 3: Significance Test between Survival Rates in Figure 4

	DV: Survival	*DV: Menu Changes*	*DV: Survival*	*DV: Survival*
Variable	*(1)*	*(2)*	*(3)*	*(4)*
Rent Prices	-0.29**	-0.01		-0.32**
	(0.10)	(0.05)		(0.10)
Menu Changes			-0.19	-0.20.
			(0.12)	(0.11)
R^2	0.02	0.0003	0.008	0.04
Adj. R^2	0.02	-0.003	0.005	0.03
*Note: *p<0.05, **p<0.01, ***p=0.001*				
Standard errors in parentheses				

Note. The event of restaurant death is the dependent variable.

Table 4: Mediation Analysis

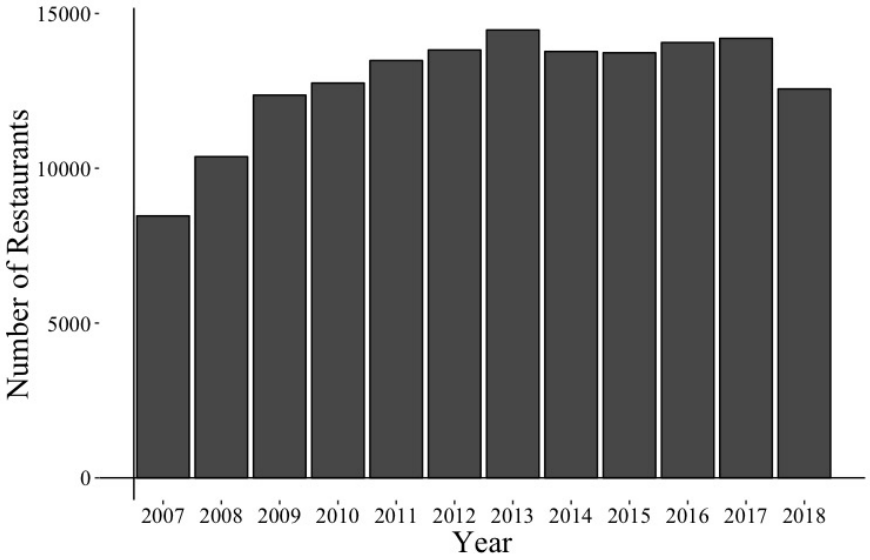


Figure 1: Number of Active Restaurants over the Years

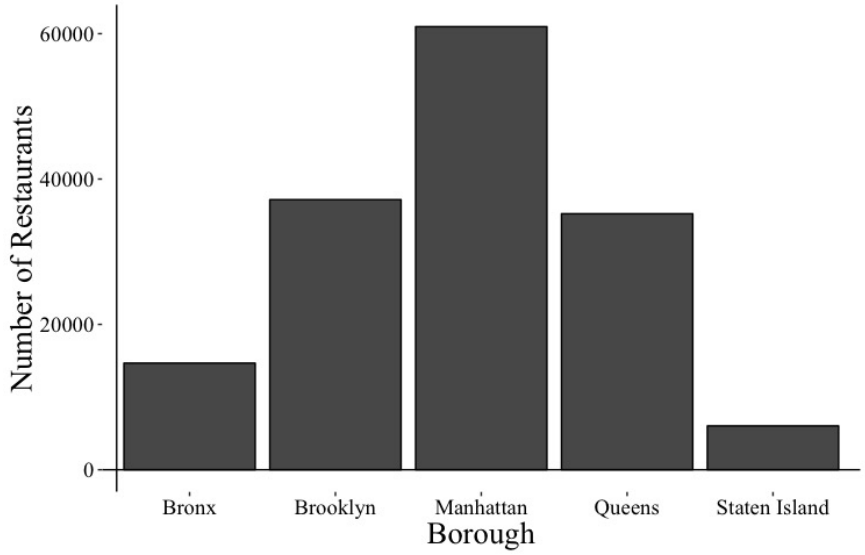
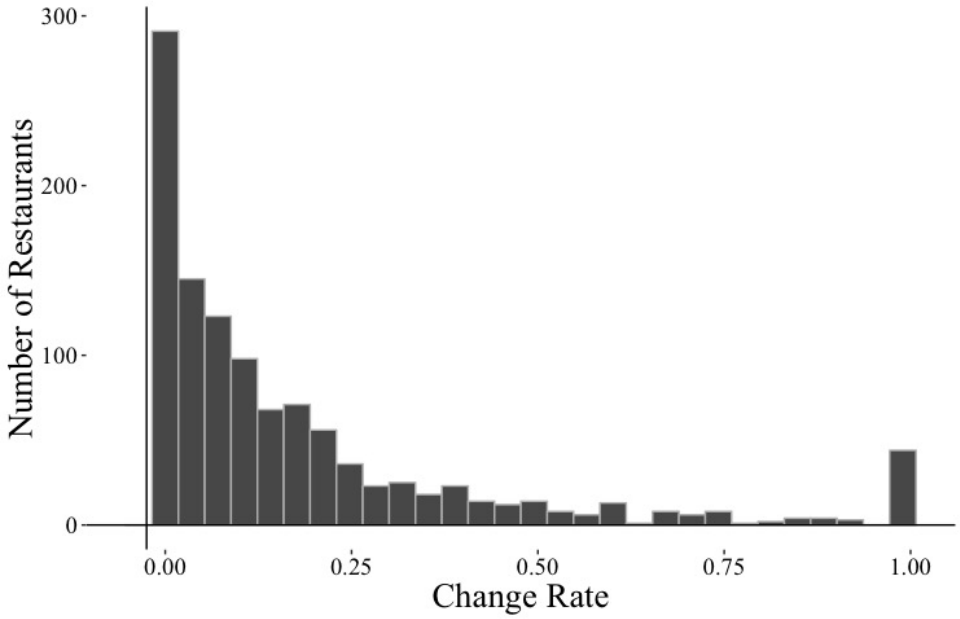


Figure 2: Number of Active Restaurants across boroughs



Note. Change refers to changes in items of sections on a menu.

Figure 3: Distribution of Menu Change Rates

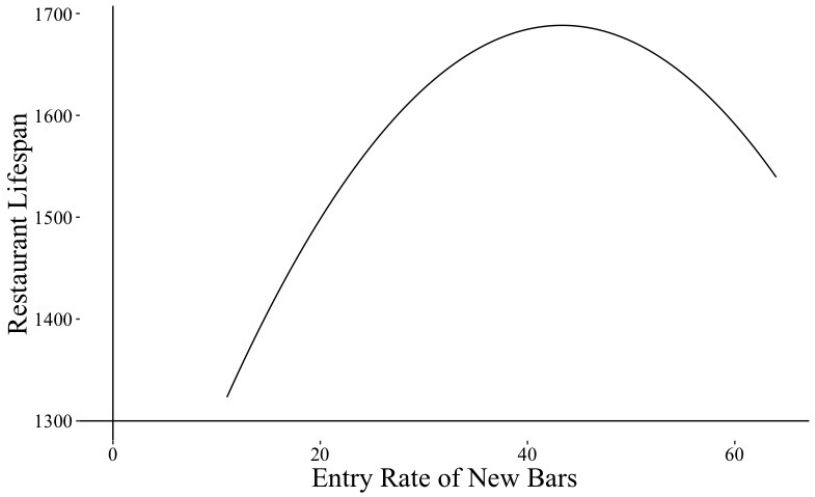


Figure 4: Inverted U-shape of the Effect of Entry Rate of Bars on Restaurant Lifespan

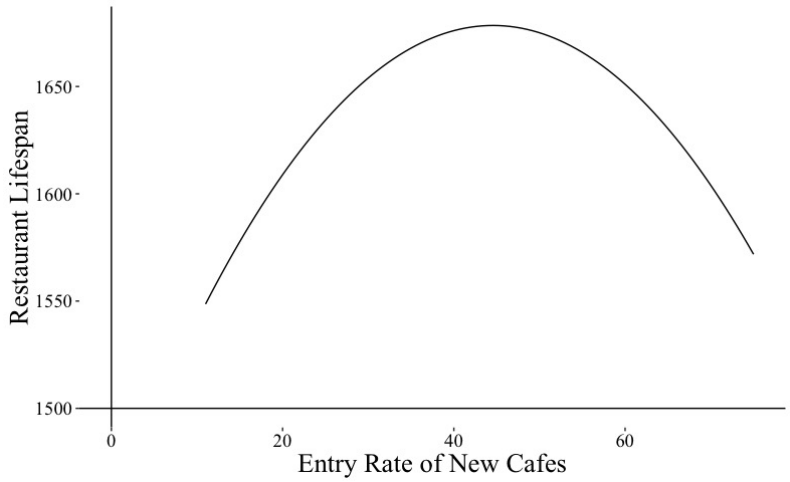


Figure 5: Inverted U-shape of the Effect of Entry Rate of Cafés on Restaurant Lifespan

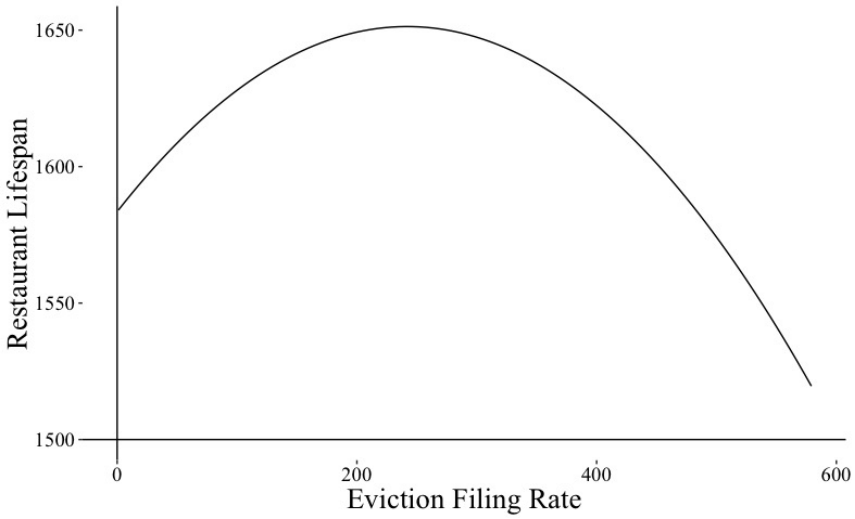
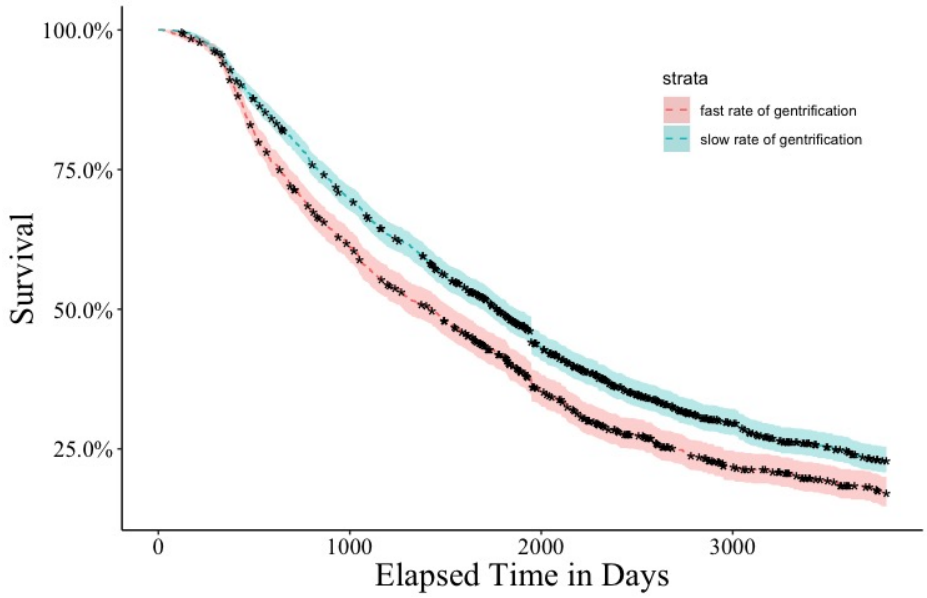
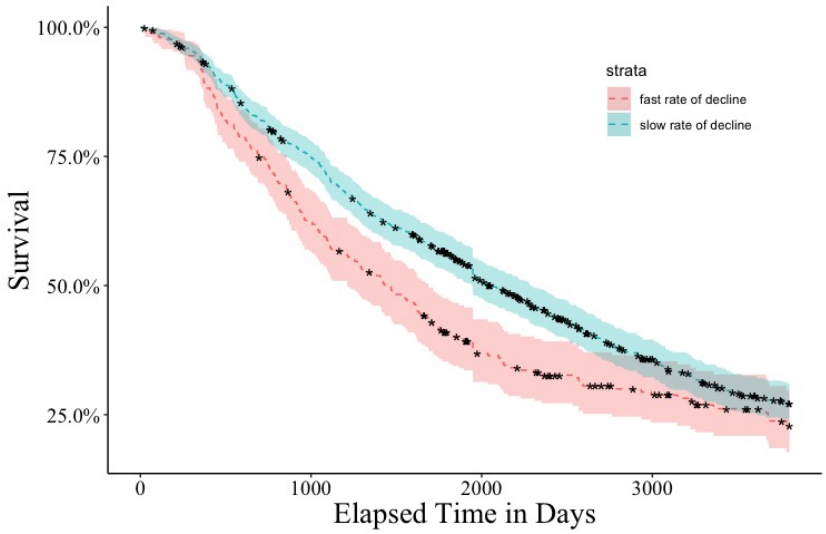


Figure 6: Inverted U-shape of the Effect of the Rate of Eviction Filings on Restaurant Lifespan



Note. From 13 NYC neighborhoods.

Figure 7: Differences in Survival Rates between Restaurant Exposed to Gentrification at Fast (strata=0) versus Slow Rates (strata =1)



Note. From 19 NYC neighborhoods.

Figure 8: Differences in Survival Rates between Restaurant in Relatively Declining Neighborhoods