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Doing More With Less!

How Population Density Impacts the Product Scope  
Strategies of Real Ale Breweries in the United Kingdom

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Product Scope Strategies of Real Ale  
Breweries in the United Kingdom

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Mirjam Karsch

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# Table of Contents

<b>1. Introduction .....</b>	<b>1</b>
<b>2. Literature Analysis.....</b>	<b>4</b>
2.1. An Overview of Product Scope Strategy .....	4
2.2. An Overview of Population Density .....	8
<b>3. A Population Density Perspective on Product Scope Strategy .....</b>	<b>12</b>
<b>4. Data and Methods .....</b>	<b>16</b>
4.1. Brewing Industry .....	17
4.2. Data Sources.....	23
4.3. Construction of Dependent, Independent, and Control Variables.....	25
<b>5. Analysis of Regression Results .....</b>	<b>33</b>
5.1. Main Analysis.....	33
5.2. Additional Analysis .....	39
<b>6. Discussion.....</b>	<b>43</b>
6.1. Contributions to Literature .....	44
6.2. Implications for Managers.....	49
<b>7. Conclusion.....</b>	<b>50</b>
<b>8. Limitations .....</b>	<b>51</b>
<b>9. Recommendations for Future Studies.....</b>	<b>53</b>
<b>10. References .....</b>	<b>54</b>
<b>11. Appendices .....</b>	<b>71</b>

## List of Figures

Figure 1 –	Entries and Exits of Real Ale Breweries in the United Kingdom (2000 - 2018) ...	19
Figure 2 –	Number of Real Ale Breweries in the United Kingdom (2000 - 2018) .....	20
Figure 3 –	Number of Launched Real Ale Beers in the United Kingdom (2000 - 2018).....	21
Figure 4 –	Style Dispersion of Launched Real Ale Beers in the United Kingdom (2000 - 2018) .....	21
Figure 5 –	Geographical Location of Real Ale Breweries in the United Kingdom in ..... 2000 (left) and 2017 (right) .....	22
Figure 6 –	Geographical Location of Launched Real Ale Beers in the United Kingdom in ..... 2001 (left) and 2018 (right) .....	22
Figure 7 –	Marginal Linear Effect of Distance (ln) on Number of ..... Product Launches (Hypothesis 1).....	34
Figure 8 –	Marginal Linear Effect of Distance (ln) on Style Dispersion of ..... Product Launches (Hypothesis 2).....	37
Figure 9 –	Marginal Curvilinear Effect of Distance (ln) on Number of ..... Product Launches (Hypothesis 1).....	40
Figure 10 –	Marginal Curvilinear Effect of Distance (ln) on Style Dispersion of ..... Product Launches (Hypothesis 2).....	40

## List of Tables

Table 1 –	Summary Statistics and Correlation Matrix for Variables Used to Test .....	
	Product Scope Breadth (Hypothesis 1).....	32
Table 2 –	Summary Statistics and Correlation Matrix for Variables Used to Test .....	
	Product Scope Depth (Hypothesis 2).....	32
Table 3 –	Regression Results for Product Scope Breadth (Hypothesis 1) with Random-Effects Negative Binomial Regression .....	35
Table 4 –	Regression Results for Product Scope Depth (Hypothesis 2) with Random-Effects Panel Regression.....	38

## List of Appendices

Appendix 1 – Regression Results for Product Scope Breadth (Hypothesis 1) with Fixed-Effects Negative Binomial Regression .....	72
Appendix 2 – Regression Results for Product Scope Depth (Hypothesis 2) with Fixed-Effects Panel Regression.....	73
Appendix 3 – Regression Results for Product Scope Breadth (Hypothesis 1) with Random-Effects Negative Binomial Regression excl. Relative Firm Size .....	74
Appendix 4 – Regression Results for Product Scope Depth (Hypothesis 2) with Random-Effects Panel Regression excl. Relative Firm Size.....	75
Appendix 5 – Regression Results for Product Scope Breadth (Hypothesis 1) with Zero-Inflated Negative Binomial Regression .....	76
Appendix 6 – Regression Results for Product Scope Depth (Hypothesis 2) with Random-Effects Panel Regression and Number of Different Styles per Launch.....	77
Appendix 7 – Regression Results for Product Scope Depth (Hypothesis 2) with Random-Effects Panel Regression and Number of Different Styles per Launch > 1.....	78

## Executive Summary

This paper seeks to explore how an organization's product scope evolves upon changing population density. Considering prior academic achievements on both focal topics, our study provides an exciting opportunity to enhance our knowledge by investigating the potential connection between them.

In more detail, we contend that the competitive component of population density is more prevalent in mature industries and narrow down our research setting accordingly. Against this background, we draw upon arguments from different conceptualizations linking competition and innovation to eventually construct our hypotheses for analyzing the effect of population density on product scope expansions. Specifically, we claim that the two dimensions of an organization's product scope – namely product breadth and product depth – are positively affected by population density.

To test these two assumptions under a quantitative research approach, we collected firm- and product level data within the British real ale brewing industry between 2000 and 2018 upon which we were able to construct our own dependent and explanatory variables. This mature market reveals a considerable degree of heterogeneity on the number and organizational characteristics of active firms as well as on the length and style dispersion of their product lines over time. It therefore serves as a suitable research setting for examining the relationship between product scope and population density.

We find that breweries facing a high population density are more likely to introduce new products than organizations that launch under a low population density. Additionally, breweries are under this scenario prompted to specialize their product launches in a few style categories. Whereas the first observation on product breadth is in line with the reasoning given in previous literature, we assert that organizations deliberately restrict their product depth to a few style categories owing to handling of cost constraints, preventing of learning myopia, and erecting of entry barriers for potential competitors.

Our study contributes to the field of strategy in several ways. First, it enhances the current literature on density-dependence by drawing attention to the strategic behavior of alive firms. Whereas prior density-dependence research merely focuses on firm birth and firm death, we investigate the strategic moves of existing organizations with regards to their product scope introductions. Second, we illustrate that population density exerts different effects on product breadth and product depth and thus reconcile the two prevalent streams on innovation and competition. As such, we add to



the present literature on product scope that rigorously elaborated on a variety of other critical determinants of a firm's product line. Third, our results emphasize that managers should maintain dual awareness of both exploration and exploitation when deciding to proliferate their company's current product scope. In particular, launching additional products onto new market segments within a few already applied style categories constitutes a reasonable and cost-efficient approach to strategically behave in a mature business environment.

We anticipate that our study results are to a large extent generalizable towards industries with similar features to those of the real ale brewing industry in the United Kingdom. As such, comparable studies should confirm population density as an important determinant of product scope expansions and should henceforward be explicitly considered when analyzing the product line decisions taken by extant companies.

## 1. Introduction

Population ecology scholars have widely recognized that changes in organizational populations are largely driven by demographic processes of firm birth and firm death. Specifically, the well-known density-dependence theory by Hannan and Freeman (1989) synthesizes both institutional (DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Meyer & Scott, 1983) and ecological (Hannan & Freeman, 1977) perspectives to explain entry and exit rates in organizational populations with the number of extant organizations – that is, with population density.

Since the emergence of this stream, researchers have extensively studied the effects of population density on organizational formations and dissolutions and gained valuable insights (see Singh and Lumsden (1990) for a comprehensive review). The central proposition of the density-dependence model is that the rates of firm creation and firm demise are reversely affected by both legitimacy of the organizational form and competition for limited resources among the organizations within a population. More precisely, whereas founding rates initially increase with population density up to a certain point, they subsequently decrease as the number of organizations rises further. This is because the early growth in market participants leads to an increased legitimacy of the organizational form itself, which consequently encourages more organizations into the population. In contrast, mortality rates decrease until a certain level of population density and increase afterwards, since the level of competition intensifies with a rising number of firms.

In defiance of these important academic achievements, we have little knowledge about how population density influences alive actors' strategic behavior. We address this gap by investigating how an altering population density affects the product scope strategies of active organizations. In particular, we employ a density-dependence perspective on product scope broadening and product scope versioning to examine how population density impacts product scope additions of surviving firms. We consciously decided to concentrate our analysis on product scope proliferation strategies, because they represent a major strategic initiative that firms undertake to survive and successfully operate in a challenging business environment (Giarratana & Fosfuri, 2007).

Some papers have already studied the motives for product scope proliferation under an evolutionary perspective. In particular, a legitimacy approach has previously been widely used to explain how organizational identity determines such product line adaptations (McKendrick & Hannan, 2014; Vergne, 2012; Verhaal, Khessina, & Dobrev, 2015). However, little attention has been given to the contribution of competition to product scope adjustments under this research stream. While prior studies applying an evolutionary perspective drew upon competition to explain the causes of

both increased mortality rates and erected entry barriers by incumbent firms (Bonanno, 1987; Hannan & Freeman, 1977, 1989; Schmalensee, 1978), the impact of competition was scarcely explored when considering the product-specific behavior of surviving organizations under this perspective. By extending the density-dependence theory to the product scope proliferation strategies of alive actors, this paper complements prior findings on organizational founding and mortality and thus contributes, first and foremost, directly to the density-dependence research. We posit that the neglected perspective on the strategic endeavor of extant organizations bears potential for further enhancing our understanding of this theoretical concept. Moving beyond the effect of population density on firm entry and firm exit is crucial and much needed, because we would otherwise ignore tracing how a substantial proportion of market participants strategically behaves and evolves when taking the presence of other organizations into account. It is commonly known that organizations engage in both incremental and revolutionary change processes that are driven by technology, competitors, regulatory events, or changes in the economic and political environment (Tushman & O'Reilly, 1996). Building on these drivers and the earlier raised argument of changed competition upon altering population density offers, in our opinion, a fruitful basis for further investigation that we will capitalize on in the course of this paper.

Besides refining our current understanding of the density-dependence theory, we contribute more broadly to the vast amount of literature on product scope proliferation strategies. Explicitly acknowledging population density as a determinant of product line adaptations by existing organizations adds to the prevalent research on product scope, that hitherto mainly devoted great efforts to understand the manifold benefits, detriments, reasons, and drivers of a certain product line strategy (Bayus & Putsis, 1999; Kekre & Srinivasan, 1990; Patel & Jayaram, 2014), or the effect of product line extensions and specializations on performance (Barroso & Giarratana, 2013; MacDuffie, Sethuraman, & Fisher, 1996). For instance, we already know that previous studies have identified product scope differentiation strategies both across the dimension of breadth, where product variety is offered in different sub-markets (Barroso & Giarratana, 2013; Siggelkow, 2003), and across the dimension of depth, where product variety concentrates within the same sub-markets instead (Ramdas, 2003; Sorenson, 2000). Still, literature has little explored how organizations balance these two aspects when expanding their current product scope. We thus shift attention to how these two facets are modified when population density changes as time goes by. As such, we introduce a further potential determinant for product scope proliferation that has so far received little attention in academic research. Stressing that the competitive aspect of population density plays an essential role in affecting product

line adaptations is important, because it underscores how exactly organizations are incorporating changes in their external business environment when adjusting their current product scope.

Finally, we contribute to the existing literature on organizational learning by enhancing our understanding of which activities firms focus on when they introduce new products onto the market. As such, our study also bears important managerial implications. Specifically, we highlight that simultaneous exploration and exploitation play an essential role in gaining efficiency in product line extensions. Scholars have already largely acknowledged the concept of organizational ambidexterity by agreeing that these two activities are fundamental for organizational survival (Cao, Gedajlovic, & Zhang, 2009; He & Wong, 2004; Tushman & O'Reilly, 1996). We, however, provide a fine-grained analysis on product scope strategies by highlighting that firms internally focus on exploiting a few core competencies while at the same time exploring new market segments when introducing new products onto the market. In doing so, we emphasize that this ambidexterity represents a cost-efficient way to launch additional products. That is, we enhance previous findings by providing practical suggestions for managers for how to react ambidextrously upon intensified market competition.

Altogether, despite the widespread academic interest in product scope strategies and density-dependence theories, our study is, to the best of our knowledge, the first one analyzing these two research streams in combination. Consistent with the above-outlined flaws of other studies, we diagnose that the linkage between population density and product scope adjustments needs further investigation. Accordingly, the objective of our research is to complement each perspective by empirically examining this connection. We emphasize the competitive component of population density in a mature market and utilize firm- and product level data of the well-developed UK-national real ale brewing industry to analyze how population density impacts the number and style variation of launched products. We believe it is essential to disaggregate an organization's product scope into its two dimensions as this allows us to rigorously test the effect population density exerts on each of them and thereby reconcile previous research that solely focused on either of those two aspects.

Considering these arguments, our research question is as follows:

*How does Population Density Impact the Product Scope Strategies  
of Real Ale Breweries in the United Kingdom?*

Our regression results reveal that population density leads, on the one hand, to more product launches. On the other hand, these additional products are characterized by a low style variation. Accordingly, our results demonstrate that product scope expansions do not necessarily need to happen via a broad array of styles, but that existing knowledge within a few core areas can be exploited for new products when reacting upon intensified competition in the market.

The remainder of our paper is structured as follows. We begin by reviewing the vast academic conceptual and empirical literature that previously addressed population density and product scope proliferation, respectively. In that sense, we present the theoretical foundations for our research, which we now aim to apply to one particular sector of the much larger brewing industry in the United Kingdom. Using the findings of existing literature focusing on the relationship between innovation and competition, we derive two testable hypotheses as a basis for our statistical analysis. In the subsequent section, we provide a brief overview of the UK-national real ale brewing sector and particularly focus on its firm and product development between 2000 and 2018. After introducing our chosen methodology and research approach, we detail our dependent and explanatory variables and specify various control variables. In the penultimate section, we present and explore our findings and subsequently discuss the contributions of our empirical results to academia and management. We conclude our thesis with a summary of the whole study, acknowledge its limitations, and finally identify directions for further research.

## **2. Literature Analysis**

In the following section, we outline both conceptual and empirical papers to give an overview of previous achievements in the fields of product scope and density-dependence. In doing so, our review will legitimize the necessity of finding an answer to our above-stated research question.

### **2.1. An Overview of Product Scope Strategy**

An organization's product scope consists of two different, though related components, namely product breadth and product depth. These dimensions are defined as the number of products offered by a firm at a given time and the degree of product versioning, respectively (Anderson, 1995; Barroso & Giarratana, 2013).

Many studies have investigated why organizations adapt their present product scope. Notably, it has been claimed that the rationale behind introducing new products lies in an organization's

attempt to improve the content of its currently pursued strategy. That is, getting more attractive for customers, enhancing its ability to retain revenues as profits, and, in general, improving its possibility to withstand competition from rivaling firms (Barnett & Freeman, 2001). As such, a large number of new product introductions, a wide product variety, as well as long product lines are typical attributes for firms proliferating their present product scope (Connor, 1981).

Any of these adaptations represents an impactful organizational decision, that needs to take multiple factors into account. As such, Warell (2001) asserts that both internal and external environmental causes and their financial implications need to be considered when opting for product scope adjustments. These factors are, first, a product's phase in the product life cycle, which duration impacts the associated product costs and complexity of the overall product process; second, the size of a firm's existing product portfolio, which not just positions the firm in the market, but also inhibits rivals from entering it; and, third, the resources a firm devotes to implement its intended product design.

Not every firm can afford to offer a broad and varied product scope. This is because a change in an organization's product line can have several implications. In particular, a high product variety generally necessitates complex organizational processes for both assembly and supply (Hu, Zhu, Wang, & Koren, 2008). Consequently, costs for inventory and training (Van Ryzin & Mahajan, 1999) and assembly cycle times could rise significantly (Xia & Rajagopalan, 2009), whereas capacity slack could decrease (De Groote, 1994). Furthermore, an organization's structure and coordination capabilities may influence its operational performance. Therefore, Patel and Jayaram (2014) argue that considerations on process modularity and manufacturing flexibility also matter when striving for successful product scope modifications. The former one consists of the standardization, re-sequencing, and postponement of organizational processes that together define the main rules for the overall process design within an organization. The latter one, in contrast, executes these design rules for products and processes at an operational level. Contrary to prior studies (Fisher & Ittner, 1999), Patel and Jayaram (2014) predict that product variety exerts an inverted U-shaped effect on operational performance, which can be managed through highly flexible manufacturing processes. This is because manufacturing flexibility increases the potential advantages of a broad product variety while at the same time reducing the high costs of such a product scope strategy.

The aforementioned elaborations are contingent on different factors. More precisely, depending on an organization's size and maturity as well as on its exposure to competition, different types of product scope change may best suit a particular organization. For example, mature organizations

differ substantially from emerging ones in their competencies, experience as well as in their endowment with monetary and human resources from emerging ones. Likewise, different firm sizes determine different levels of organizational and financial flexibility, thereby constraining or enabling product scope adjustments. However, even if to a varying degree, firms will generally face changes to their engineering designs, material specifications as well as process and manufacturing schedules and routines when pursuing greater product variety (Fisher & Ittner, 1999).

Besides its complexity, the degree of product scope proliferation is most of all a strategic decision (Eggers, 2012; Ramdas, 2003; Sorenson, 2000) that entails both benefits and costs. Proliferating its current product scope enables a firm to more precisely meet heterogeneous consumer preferences (Connor, 1981; Draganska & Jain, 2005; Quelch & Kenny, 1994), which should eventually positively impact customer demand (Bayus & Putsis, 1999), sales volume (Kadiyali, Vilcassim, & Chintagunta, 1998; Perloff & Salop, 1985; Salop, 1979), and sales price (Moorthy, 1984). Similarly, it has been empirically confirmed that a broader product line results in a higher market share (Kekre & Srinivasan, 1990; Roberts & Samuelson, 1988; Robinson & Fornell, 1985). Beyond that, a higher product variety creates barriers to entry for new firms by filling product spaces in a way that leaves little unmet demand for potential new entrants (Bonanno, 1987; Brander & Eaton, 1984; Ramdas, 2003; Schmalensee, 1978), which can, in return, enable incumbent firms to increase their market prices (Benson, 1990; Levy & Reitzes, 1993; Putsis, 1997). Additionally, further entry barriers make it difficult for new entrants to compete, since incumbent firms utilize firm-specific assets like brand names and technology (Li & Greenwood, 2004), capitalize on learning effects (Campa & Kedia, 2002; Stern & Henderson, 2004), and create operational and managerial synergies, which lead to economies of scale and scope (Gimeno & Woo, 1999; Tanriverdi & Lee, 2008).

However, according to other studies, product scope proliferation negatively affects firm performance (Anderson, 1995; MacDuffie et al., 1996). This is because, as partially indicated earlier, a higher product variety also entails higher costs, arising from more complex assembly and supply processes (Hu et al., 2008), increased control and coordination (Barnett & Freeman, 2001; Jones & Hill, 1988; Quelch & Kenny, 1994) as well as from the so-called learning trap (Rivkin, 2000; Stern & Henderson, 2004).

To mitigate possible threats through increased costs and organizational complexity, some firms see advantages in offering a narrow product line. One reason is that a lower number of products can lead to more production efficiency. This is because coordination is easier (Lawrence & Lorsch, 1967), resulting in less necessary overhead. Another reason is that a tighter product range results

in lower inventory and storage costs because firms with a narrow product scope need to have less variety of inputs available (Kekre, 1987). However, empirical tests on the relationship between product line breadth and costs show mixed findings: While some studies find a positive relationship between a broad product line and direct costs (Abegglen & Stalk, 1985; Lubben, 1988) and inventories (Lubben, 1988), Kekre and Srinivasan (1990) find no evidence that broad product lines are associated with either higher inventories or direct production costs.

Some studies have tried to identify the most appropriate product scope diversification strategy. The optimal firm-specific product mix is subject to organizational and market conditions but also strives to find the most competitive outcome resulting from the mutual relationship between the two. According to some researchers, the most suitable product scope diversification strategy originates from exploiting the successes of previously launched products. As such, when a firm introduces new products similar to those already offered, its operational and management processes become more efficient due to learning-by-doing factors (Kogut & Zander, 1992; Smith, Collins, & Clark, 2005). Similarly, it has been empirically proven that a higher firm experience in a certain niche raises the quality of new products offered in that respective niche (Eggers, 2012). Moreover, Sorenson (2000) finds that the optimal choice of product variety is contingent on the competitive ecology of the respective industry: While generally a broad product range becomes less important as the total number of products in the market rises, it becomes more valuable when uncertainty in the market impairs a firm's ability to accurately predict customer demand.

Other studies have observed a disrupting effect of product scope enhancements. In spite of the strategic advantages mentioned earlier, introducing new products may lead to disruptions of organizational structures, processes, capabilities, norms, roles, partnerships, and the like. Interestingly, Barnett and Freeman (2001) observe that these disruptions are particularly severe when a firm launches several new products concurrently, which increases the hazard for organizational failure – although for just a finite period. While they find that a large number of products in itself decreases organizational mortality, the introduction of multiple products at the same time increases mortality rates.

Product scope differentiation is not always beneficial. On the one hand, structural competitive factors exert a significant influence on the determinants and market outcomes of an organization's product line decision (Bayus & Putsis, 1999). On the other hand, the fit of organizational structures depends on environmental characteristics, such as the industrial and competitive context, as well as on the life stage of the particular firm and industry. Therefore, both organizational structures



and prevalent market conditions could either strengthen or mitigate the positive effects of introducing new products onto the market (Barnett & Freeman, 2001; Sorenson, 2000).

Another stream of literature has studied the contribution of different types of product scope diversification to organizational performance by considering market dynamics. As such, even though product line expansion is at times observed to positively affect performance (Barnett & Freeman, 2001), some papers argue that the extent to which product scope proliferation strategies can be beneficial strongly depends on market complexity (Barroso & Giarratana, 2013), which is referred to the degree of heterogeneous products marketed. Specifically, there are two different streams concerning product scope diversification: First, across-niche product scope proliferation, under which firms sell products in different sub-market niches; and second, within-niche product scope proliferation, under which firms expand the number of product variants that they offer in a single sub-market. Barroso and Giarratana (2013) find that, when exposed to different conditions of market complexity, the two product diversification strategies impact organizational performance through different behaviors.

## 2.2. An Overview of Population Density

Population ecology theory has been extensively used over the last decades to study organizational diversity. Broadly speaking, population ecologists contend that external forces of organizational selection and replacement lead to changes at the overall population level (Carroll, 1988) – an argument that ultimately helps them to analyze macro-organizational phenomena. By focusing their analysis on the population rather than on the individual firm level, this evolutionary perspective enables researchers of this field to examine life histories of all organizations through a spatial perspective of the market, in which each organization fills a particular area of the market space.

Population ecology research can be divided into a vast array of different research streams, with prominent examples such as niche-width theory (Hannan & Freeman, 1977), resource-partitioning theory (Carroll, 1985), liability of newness and smallness (Aldrich & Auster, 1986; Stinchcombe, 1965), and density-dependence theory (Hannan & Freeman, 1989). We acknowledge the academic importance of all these major theories and concepts, though restrict our subsequent review to the latter one as we consider it as most important for our further argumentation.

Contrary to traditional static theories, where weak organizations die due to selection processes and are replaced by new organizations, the density-dependence model has been widely used to

understand organizational *dynamics* determining organizational failure (Barron, West, & Hannan, 1994; Hannan & Freeman, 1989; Sorenson, McEvily, Ren, & Roy, 2006) or encouraging new entries (Dowell & Swaminathan, 2006). Consistent with these population dynamics, the density-dependence theory proposes that the rates of organizational founding and mortality are altered by the number of organizations existing in a population at a certain point of time (Hannan & Carroll, 1992). That is, population density can be defined as the number of firms racing for similar valuable resources in an environment to continuously sustain their competitive advantage (Barney, 1989; Miller & Eden, 2006). In particular, these resources represent any type of input that is available at only a few locations (Sorenson & Baum, 2003), such as low costs for transportation and production (Hoover, 1948) or regional identity (Romanelli & Khessina, 2005).

According to the density-dependence perspective, competition and legitimacy are two opposing functions of population density. Legitimacy constitutes an important concept of the institutional theory and refers to the social justification of an actor, such that the actor is publicly validated or endorsed (Perrow, 1961). As such, legitimacy varies across firms. Previous literature has proven the strategic importance of legitimacy (McKendrick & Hannan, 2014; Verhaal, Hoskins, & Lundmark, 2017). For instance, prior studies on the identities of organizational forms have revealed that sharp and focused firm identities are more appealing to customers than diffuse and category-spanning identities (Hsu, Hannan, & Koçak, 2009; McKendrick, Jaffee, Carroll, & Khessina, 2003). Social expectations can therefore modify a firm's position in the market. On the contrary, not meeting customers' expectations may lead to growing dissatisfaction or even loss of customers (Barlow, Verhaal, & Hoskins, 2016; Hudson, 2008; Hudson & Okhuysen, 2009; Vergne, 2012). Nonetheless, this social endorsement process lets legitimacy succeed and competition mitigate. As organizations in a population become embedded in their local institutional environment, these established relations bestow survival advantages of single organizations by providing them with resources and legitimacy (Baum & Oliver, 1992; Meyer & Scott, 1983). Accordingly, most of the theories on legitimacy explain how organizations are successful in entering the market (Dobrev, Kim, & Carroll, 2002; Verhaal et al., 2015) and in surviving to increased competition at a founding stage (Carroll & Hannan, 1989a; Verhaal et al., 2015).

Besides its influence on legitimacy processes, a varying organizational density within a population affects the availability of resources, which eventually alters the competition within the population. In other words, competition can be defined as the indirect influences from organizations aiming to access the same limited resources in the market (Singh, 1993).

In light of these explanations, population density exerts two distinct effects on the rates of organizational formation and extinction: When population density is low, legitimacy processes dominate and will lead to high founding and low mortality rates. This is because the organizational form itself gets more, yet at a decreasing rate, taken for granted, i.e. legitimized, as the number of organizations in a population increases. In contrast, a high population density implies an increasingly intense competition among individual organizations for scarce resources, which will result in high mortality and low founding rates. By virtue of these two main arguments on legitimacy and competition, prior firm birth can influence patterns of current founding rates, whereas failures on resource availability can influence firm death (Delacroix & Carroll, 1983).

Altogether, legitimacy and competition are two density-dependent processes that behave non-monotonically – contingent on the prevalent degree of population density. That is, both social and environmental conditions impact the rates of firm emergence and firm dissolutions in organizational populations. In a recently established market environment, legitimacy dominates competition as selection pressures decrease with rising population density, thereby reducing mortality rates. Yet, at a later range of population density, competition prevails and selection pressures increase as population density rises, which increases mortality rates.

The claimed effects of population density have been empirically confirmed in a variety of different research settings, such as labor unions (Hannan & Freeman, 1987, 1988), social service organizations (Tucker, Singh, Meinard, & House, 1988), semiconductor manufacturing (Brittain & Wholey, 1988; Hannan & Freeman, 1989), and telephone companies (Barnett & Carroll, 1987). These respective organizational populations are not only characterized by different national and historical contexts, but also differ in their exposure to market mechanisms and degree of institutional embeddedness. Thus, as the theory on density-dependence is mainly supported across these diverse populations, the above-outlined relationships between organizational founding and mortality are largely generalizable.

Notwithstanding this strength of generalizability, both population ecology and in particular density-dependence have been exposed to much criticism (see, for instance, Donaldson (1995); Perrow (1986); and Young (1988)). Notably, the density-dependence model has been blamed for not operationalizing the institutional processes such as legitimacy, which constitutes a major explanatory factor in the model (Petersen & Koput, 1991; Zucker, 1989). It is, for example, asserted to be particularly unfortunate that the central processes of legitimacy and competition are merely tested, rather than studied directly to clearly demonstrate the linkage between these two (Zucker,

1989). However, proponents of this theory argue that this indirect treatment of legitimacy is in conformance with well-known institutional theories (see Carroll & Hannan (1989b) for further details). Moreover, solely counting the number of organizations within a population is considered as insufficient, as it ignores the conceivably stronger competitive advantage of large organizations (Singh & Lumsden, 1990). Therefore, researchers tried to mitigate this flaw by weighting each organization by its firm size in a so-called population mass density (Barnett & Amburgey, 1990). Lastly, a potential lack of data on the early history of a certain population may lead to discrepant findings for organizational mortality (Delacroix, Swaminathan, & Solt, 1989; Tucker et al., 1988). Similarly, omitting these data is particularly problematic for correctly capturing the legitimacy-enhancing effect, which population density exerts at the beginning of a population's development.

Despite all these strong academic achievements on population density and product scope, our brief literature review clearly shows the need for refining our prevalent understanding of both focal topics by considering them in combination.

Prior density-dependence literature seems not to have recognized the significant effects of population density beyond firm mortality and founding. In particular, even though legitimacy theories strongly contribute to the ecology literature, they only partially explain the rationale behind product scope adaptation processes, limiting their validity to founding phases, where identity differentiation strategies are highly valuable. However, considering the presence of other actors, we still do not understand how organizations adjust their current product line in mature industries, where competition prevails, and the effects of social endorsements are evenly distributed among active firms.

Albeit we already know that offering a broad range of different products increases the likelihood of addressing heterogeneous customer demands and deterring rivals from entering the market, existing literature poorly explains how organizations manage the related cost constraints when diversifying. Since product scope adaptation is, however, a practice extensively used by extant organizations in different stages of their organizational life cycle and across organizations with different product scopes, in this paper we aim to investigate how the competitive dynamics between surviving firms in a certain population contribute in explaining their product scope adaptation strategies.

### **3. A Population Density Perspective on Product Scope Strategy**

Product scope proliferation is a strategic choice (Eggers, 2012; Ramdas, 2003; Sorenson, 2000). As elaborated on earlier in greater detail, its benefits include economies of scale and scope from operations and management synergies (Tanriverdi & Lee, 2008), learning (Stern & Henderson, 2004), entry barriers reflecting saturated product niches (Lancaster & Ratchford, 1990), and the ability to utilize firm-specific assets, such as brand names and technology (Li & Greenwood, 2004). Moreover, literature finds that the development of industrial processes and methods strongly contributes to improved product innovations, and by so doing, to enhanced market reach and efficiency (Ganzer, Chais, & Olea, 2017). Accordingly, product innovation is a fundamental enabler for organizational growth.

Variations in product scope are decisions based on both internal and external factors (Bayus & Putsis, 1999; Giachetti & Dagnino, 2014; Warell, 2001), and thus need to incorporate organizational structures and capabilities as well as contemplate existing market dynamics. Besides their individual goals and objectives, firms remain socio-economic entities tied up to specific market rules, where their likelihood for survival depends on competition as the number of rivals in the market increases (Hannan & Freeman, 1977). Consequently, variation in population density strongly affects the extent of competitive behavior among market participants. Engaging in product scope expansion strategies under different conditions of market development entails thus both diverse opportunities and detriments for organizations that depend on how the number of firms in a population varies over time.

Firms are commonly considered as profit-maximizing entities that compete with one another for establishing market dominance (Blundell, Griffith, & Van Reenen, 1999; Nickell, 1996; Romer, 1990). However, market dominance is a social status that is determined by the number of rivals existing in the market and as such by population density. As such, the higher the number of competitors in an organizational population, the higher the strategic overlap among them and therefore, the stronger their competition for similar scarce resources (Hannan & Freeman, 1977; Singh, 1993). Consequently, establishing market dominance is substantial for a firm to ensure its survival. Organizations are therefore under a high population density incentivized to compete systematically to launch new products, industrial methods, or processes to pursue organizational growth (Schumpeter, 1943; Sledzik, 2015). However, when the number of competitors in the market increases, opportunities for growth may be threatened, thereby incentivizing firms to find survival strategies. As such,

organizations can either heighten entry barriers to deter new firms from entering the market or secure to themselves the best resources and methods to improve their current product offers.

Prominent studies argue that firms seeking market power need to innovate. Particularly, Schumpeter (1943) was among the first ones to give a clear definition of innovation as the commercial or industrial application of something new, including the launch of new products, processes, or methods of production. The improvement of industrial processes positively contributes to a higher product quality and reduced organizational costs, while the launches of new products tend to rise organizational profits and market share (Kekre & Srinivasan, 1990).

Furthermore, we find other reasons encouraging firms to compete on innovation within an organizational population. To begin with, a lack of resources in the market motivates firms to find alternatives. Specifically, when population density is low, product market competition is also low, and organizations are less likely threatened by the entrance of new firms, whereas resources are highly available. Consequently, there is hardly any incentive for those few rivaling firms to innovate and by that proliferate their current product lines (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005). On the contrary, when population density is high, market competition also increases (Hannan & Freeman, 1989). In this context, stimuli for *innovation* increase for several reasons.

First, high competition leads to higher resource scarcity (Aksaray & Thompson, 2017), which incentivizes firms to find innovative methods for their product lines. Second, not innovating can lead to fatal consequences as foregone business opportunities may ultimately result in market exit (Levinthal & March, 1993). In the same vein, various scholars argue that firms facing an entry threat of a new competitor are inclined to offer a larger number of products than they would in the absence of this threat (Hay, 1976; Prescott & Visscher, 1977; Schmalensee, 1978).

Moreover, returns on investment constitute another argument firms draw upon when introducing new products. By adapting a micro-economic point of view, researchers have widely discussed the advantages of first and second movers when considering strategies to outperform competitors. To begin with, some studies claim that it is advantageous to be the first organization to introduce a particular type of product onto the market (Lieberman & Montgomery, 1988; Williamson, 1975). *First-mover* products establish, on the one hand, a market position that will be challenging for later entrants to overtake, for instance when their product innovations carry a good reputation among customers and when they attract a loyal customer base. On the other hand, there are benefits for launching products at a later point of time, because these *second-mover* products are typically characterized by a lower price, a higher quality or both relative to pioneering products (Carroll & Teo,

1996; Dosi, 1984; Khanna, 1995; Mitchell, 1989; Nelson & Winter, 1982). As such, products of late market entrants can outperform pioneers if they are innovative and enter the market in short time after these first movers (Shankar, Carpenter, & Krishnamurthi, 1998).

According to some other studies (Aghion & Howitt, 1992; Banbury & Mitchell, 1995; Grossman & Helpman, 1991; Romer, 1990), an intensified competition among market participants exposes organizations to threats of *imitation*. In particular, this reproduction of already marketed products is supposed to negatively affect productivity growth as it reduces the monopoly rents usually resulting from new innovations. However, Lee and Zhou (2012) contradict this relationship by observing that imitation can add further value to customers. Moreover, more recent studies contend that imitation is not just merely copying a pioneer product at a lower sales price, but also its reproduction by improving it (Grahovac & Miller, 2009; Shenkar, 2010).

Considering all these arguments, it is evident that different advantages of entering the competitive field either as a *pioneer*, *second mover*, or as an *imitator* exist. In contrast, the threat of not innovating can be detrimental for organizational performance, or even fatal (Levinthal & March, 1993).

Lastly, previous studies (Schumpeter, 1943) claim that product innovation is a cyclical process through which organizations compete with each other. Under this perspective, rivaling products are reciprocally concurring in a “creative destruction” process that alternates among invention, innovation, diffusion, and imitation (Schumpeter, 1943). Consequently, if population density increases, increased competition will motivate firms to innovate iteratively.

In light of all previous elaborations, we argue that a higher population density incentivizes organizations to pursue any form of innovation, such as new product launches. More specifically, increasing population density strengthens the competitive behaviors within a population, which consequently stimulates firms to launch new products in the market to prevent losses in market positions. We therefore predict the following:

*Hypothesis 1:*

*The higher the population density, the larger a firm’s product scope expansions.*

An increase in density within a population can also occur in specific geographical agglomerations – considered as the concentration of a population in a particular local area – rather than being distributed homogeneously across several locations. According to prominent theories of clusters and organizational agglomerations, the extent of innovation depends on the context taken into consideration and is,

more specifically, facilitated through a high concentration of firms (Baum & Haveman, 1997; Porter, 2008; Sorenson & Audia, 2000) and hence through high population density.

Geographical agglomerations attract the founding of different institutions in the same area, such as suppliers, customers, rivals, or associations, like agencies and universities. According to Porter (1998b), clusters influence competition through the following three processes: First, clusters enhance the productivity of firms operating in the area; second, clusters affect the direction and speed of innovation, which supports future growth in productivity; and third, clusters prompt the establishment of new enterprises, which extends and bolsters the cluster itself.

Clustering of firms enables a location to sustain local operations (Oakey & Cooper, 1989; Visser, 1999) since agglomerated firms achieve economic benefits from the externalities of clustering (Krugman, 1991). For example, an agglomeration of many firms in a particular location creates an attractive job market for skilled workers, who intentionally go to places where their skills are demanded (Ciccone & Hall, 1996; Henderson, 2003). This leads to the constant availability of labor – a strong benefit for local firms. In the same vein, high-density areas offer greater job mobility for the self-employed. Although aggregated data at the population level suggest that local firms may experience difficulties in withstanding the intense competition in these concentrated areas, these areas might also foster entrepreneurial activity by providing potential entrepreneurs an alternative opportunity for employment in case of failure (Aksaray & Thompson, 2017).

Additionally, local suppliers are strongly incentivized to supply their inputs due to the high demand resulting from a large number of agglomerated organizations (Folta, Cooper, & Baik, 2006; Hoover, 1948). As such, these clustered firms favor from not investing in similar activities (Canina, Enz, & Harrison, 2005). Moreover, agglomeration creates possibilities for knowledge spillovers in a certain location (Audretsch, 1998, 2003; Saxenian, 1994). Specifically, firms benefit from the research and development efforts and innovation activities of other firms and organizations located in close technical proximity (Feldman, 2000). Being in closeby geographic location enhances a firm's ability to observe and imitate the innovations of other firms or to develop its own (Storper, 1993; Tallman, Jenkins, Henry, & Pinch, 2004; Tallman & Phene, 2007). Furthermore, the collective efforts in a cluster make the achievement of organizational efficiencies possible (Schmitz, 1995), through the deliberate collaboration of firms seeking to enhance the competitiveness of the cluster (Mesquita & Lazzarini, 2008; Poudier & St. John, 1996; Tallman et al., 2004).

The previous reflection on the increase of competition within geographical agglomerations is fundamental to understand the impact of population density on product innovation. According to Porter



(1998a, p. 83), “a company within a cluster often can source what it needs to implement innovations more quickly”. One of the most valuable attributes of a cluster constitutes the geographical proximity of its entities. Although this geographical concentration intensifies the competition among firms and thereby increases mortality rates (Hannan & Freeman, 1977, 1989), local suppliers and associations can and do get closely involved in the innovation process, thus facilitating to better meet customers’ expectations. Furthermore, clusters are highly attractive for entrepreneurs, due to the high availability of specialized workforce, the low transportation costs resulting from the geographic proximity, and the dynamism of knowledge transition. Accordingly, these entrepreneurs are able to acquire knowledge from other businesses, build up critical networks, and boost their confidence to establish their own business. In consequence, clusters provide greater business opportunities for entrepreneurs, which eventually rises the founding rate in the area and in that way creates a positive relationship between firm density and innovation for organizational products.

To sum up, innovation will depend on the resources available in the market. If population density increases, the likelihood of reaching out to more valuable resources for innovation also increases. We therefore predict the following:

*Hypothesis 2:*

*The higher the population density, the more diversified a firm’s product scope expansions.*

#### **4. Data and Methods**

As articulated earlier, we aim to complement other scholars’ academic achievements on population density and product scope. Specifically, we attempt to link these two focal theories by elaborating how organizations react upon the changing firm density in their business environment through product scope expansion and style diversification, respectively. Accordingly, two separate regression models need to be developed, tested, and analyzed in order to explore these potential interrelations. For that reason, this section outlines the general characteristics of the empirical setting. First, relevant insights into the investigated industry are provided in order to offer an aggregated picture of the sector, understand market-specific structures, and ultimately demonstrate the chosen industry’s suitability as an academic research field for testing our claimed hypotheses. Second, the underlying data sources of our two regression models as well as our approach for building our own dataset are outlined. Thereupon, the construction and calculation of our main dependent and independent variables are presented and thoroughly explained. In connection with

this, findings in previous academic literature will aid in determining and computing several control variables. The last paragraph deals with the outputs of our developed regression models and builds the starting point for the subsequent result analysis.

#### 4.1. Brewing Industry

As its nature, underlying practices, and characteristics are clearly demarcated and largely understood, the brewing industry represents an in academia widely used business environment for testing, applying, and enhancing miscellaneous theoretical concepts and frameworks. In fact, insights gained on entrepreneurship (Danson, Galloway, Cabras, & Beatty, 2015), strategy, structure, and performance (Johnson & Thomas, 1987), market power and industry concentration (Slade, 2004; Tremblay, Iwasaki, & Tremblay, 2005), competitive intensity (Barnett, 1997), advertising (Chandra & Weinberg, 2018; Yao, 2012), and not least population density (Carroll & Swaminathan, 2000) demonstrate the industry's eligibility as an academic research setting for a broad spectrum of topics.

The brewing industry in the United Kingdom constitutes a mature, nonetheless very active market with some still-alive firms (Shepherd Neame, 2019; Three Tuns Brewery, 2019) tracing their roots back to the 17<sup>th</sup> century. It underwent major structural changes in the 1990s characterized by, among other factors, mergers among UK-national brewing companies (Knowles & Egan, 2001).<sup>1</sup> Yet, although the British brewing sector accounts with 2,430 active breweries for only roughly a third of the magnitude of the US American one, it hosts – by far – the highest number of alive breweries in whole Europe (Brewers Association, 2019b; The Brewers of Europe, 2018).<sup>2</sup>

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<sup>1</sup> An extended account of the brewing industry in the United Kingdom between 1830 and 1980 is provided by Gourvish and Wilson (1994). Notably, this historical review covers production and consumption, markets and distribution, free trade in beer, the impact of temperance, structural change, as well as the development of large-scale breweries.

<sup>2</sup> In defiance of this impressive dimension, the sales channels of British beer manufacturers have been suffering from imbalanced economic development and strength for quite some time. While sales in the so-called off-trade sector – i.e. through wholesale and retail – increased throughout the last years, the complementary on-trade or hospitality sector decreased to an equally large extent over the same period. As such, the massive and unstoppable pub death the island nation has been facing for a while has attracted a great deal of national and international attention (Aftenposten, 2018; Spiegel, 2018; The Guardian, 2018; The Telegraph, 2019). This unfortunate development is partially encouraged by domestic supermarket chains like Tesco, Sainsbury's, and Asda, that expand their offered beer assortments more than ever before (Asda, 2017; Sainsbury's, 2016; Tesco, 2017).

Generally speaking, market participants in the beer brewing sector are either rather small or comparatively large firms that can operate as subsidiaries of larger companies or as independent firms, respectively. While major players such as AB InBev, Heineken, or Carlsberg hold several divisional headquarters or subsidiaries around the globe, independent breweries are “not connected with any other entity operating within the brewing industry” (Society of Independent Brewers, 2018a, p. 19). The brewing activities either type of firm conducts could – irrespective of these firms’ organizational size or affiliation – not be more multifaceted, but still focus on a common set of well-defined and essential tasks that include (1) malting, (2) mashing, (3) boiling, (4) fermenting, (5) bottling and aging (Beeriety, 2009). Besides these various endeavors resulting in an endless number of different beer styles and flavors (Adams, 2006), each style can primarily be classified as either ale or lager.<sup>3</sup>

Our study focuses on British breweries that mainly manufacture and sell *real ale*, which is – apart from the above-outlined activities – “produced and stored in the traditional way, [...] unfiltered and unpasteurized, and fermented in the dispense container to produce a reduction in gravity” (CAMRA, 2018a). This definition thus comprises traditional cask-conditioned ales, which are the majority of consumed ales in the United Kingdom (LWC Drinks, 2017), and differentiates real ale beers from alternatives like brewery-conditioned beers in terms of applied filtration, pasteurization, and carbonation methods and procedures (CAMRA, 2018a).<sup>4</sup>

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Additionally, diminishing economic growth rates during the last five years (Office for National Statistics, 2019), unclear impacts of the upcoming Brexit on business models, beer trade regulations, and import tariffs facing local and multinational brewers (Willis Towers Watson, 2017), as well as the ongoing popularity of alternative beverages like cider, wine, and spirits (British Beer & Pub Association, 2018; HM Revenue and Customs, 2018) do their rest in negatively affecting British beer manufacturers.

<sup>3</sup> Ales originate from top-cropping yeast (*saccharomyces cerevisiae*) and include for example IPAs, bitters, stouts, and porters. They are brewed under the traditional British brewing method, i.e. fermented at a temperature between 18 and 24 degrees centigrade and undergo a rather short and vigorous conditioning process. Lagers, in contrast, encompass for instance Bocks and Pilsners and are brewed with either bottom-cropping yeast (*saccharomyces uvarum*), specific varieties of hops, or lightly kilned malt. Their fermentation is carried out at a lower temperature of typically 10 to 15 degrees centigrade and entails long-term conditioning in tanks (CAMRA, 2018a). Additionally, high branding and advertising expenditures promote lagers as national brands, whereas ales tend to appeal through their regional image and lower advertising efforts. Yet, these differences became more and more diluted recently (Knowles & Egan, 2001).

<sup>4</sup> Besides these characteristics, we acknowledge the fundamental distinction between so-called *craft beers* and *real ales*. The former notion is precisely defined in its originating country the United States and refers to the *nature*

Exactly one third (33.1 percent) of our investigated enterprises are members of the so-called *Society of Independent Brewers (SIBA)* and thus, according to the association's membership criteria, produce at most approximately 430,000 hl or 1 percent of the total UK beer market (Society of Independent Brewers, 2018b). Besides this fact, we do not have any obvious evidence on institutional differences among our analyzed firms. Skimming their names does, at least, not indicate that any of our breweries belongs to a commonly known larger national or international brewery, but rather acts as a stand-alone entity.<sup>5</sup>

Both in absolute numbers and relative terms the British real ale brewing industry has been facing tremendous growth rates over the last two decades.<sup>6</sup> The historical pattern of entries and exits as well as the sector's overall growth are plotted in Figure 1 and 2 (on the following page).<sup>7</sup>

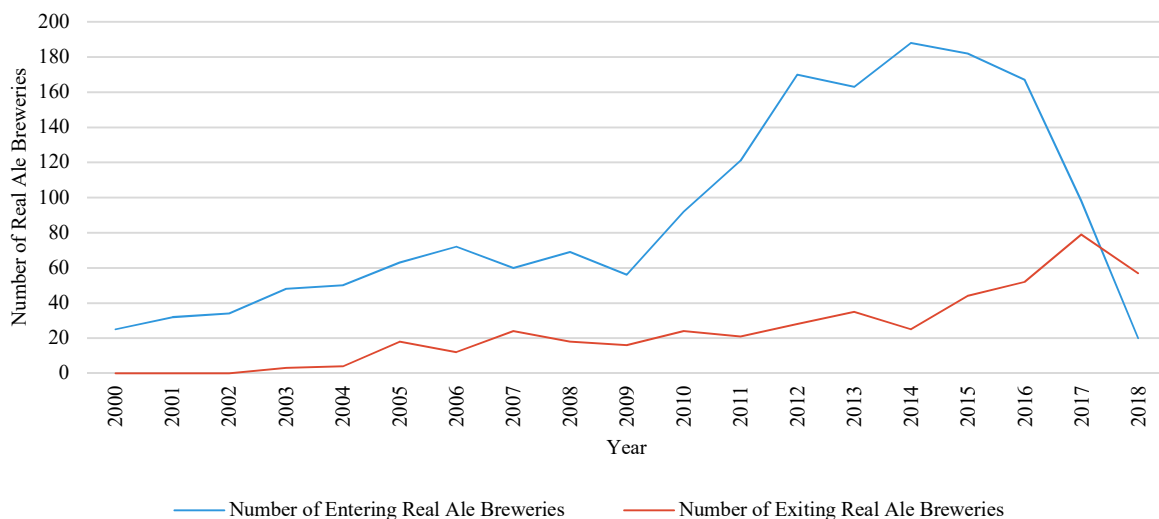


Figure 1 – Entries and Exits of Real Ale Breweries in the United Kingdom (2000 - 2018)

*of the brewer* as small, independent, and traditional (Brewers Association, 2019a) – hence clearing opposing mass producers, that enjoy economies of scale and scope in production and distribution, respectively (Adams, 2006; Knowles & Egan, 2001). By contrast and based on the above discussion, real ales denote a *specific type* of beer.

<sup>5</sup> Unless explicitly stated otherwise, the terms *breweries* and *real ale breweries* will be regarded as interchangeable and substitutable in the course of this paper.

<sup>6</sup> Major expansion has also been witnessed in various other countries, like in the United States (Brewers Association, 2019c), the Netherlands (van Dijk, Kroezen, & Slob, 2017), and Italy (Esposti, Fastigi, & Viganò, 2017).

<sup>7</sup> The following charts are exclusively based on our own dataset, which construction will be outlined in the respective section.

While in 2000 merely 321 real ale breweries started their operations across the entire United Kingdom, this figure increased substantially to 1,544 firms 18 years later. The number of our analyzed enterprises grew at an impressive average annual rate of 9.2 percent between 2000 and 2018, with the highest increase observed between 2011 and 2012 (16.2 percent). Relatedly, the British real ale brewing market shows a noticeable development in terms of high market entrances after 2009, that exceeds the market exits by a factor of up to 7.5 (in the year 2014). Following this peak, the number of additional market participants decreased, however, significantly and reached with 20 newcomers its current minimum in 2018.

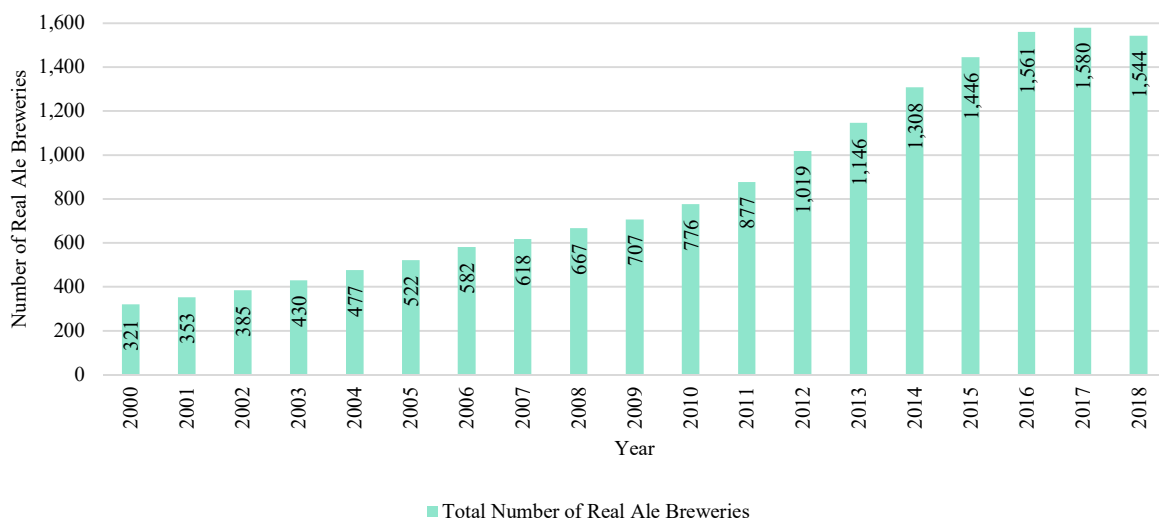


Figure 2 – Number of Real Ale Breweries in the United Kingdom (2000 - 2018)

The impressive amount of firm growth in the British brewing sector is also reflected in the increased number of product introductions into the market. While every brewery in 2000 launched, on average, 0.76 beers, this proportion rose sharply to 5.07 beers in 2018 (Figure 3 on the next page). Relatedly, the British real ale brewing market is characterized by a larger product variety in 2018 compared to 2000 (Figure 4 on the next page).<sup>8</sup> Although beers can be produced in overall eight different style categories, Anglo-American ales, like diverse sorts of IPA, as well as mild and amber ales, remain the predominant style choice throughout the entire observation period. Yet, especially stouts and porters gained increasing popularity in the last decade.

<sup>8</sup> We explicitly stress that both Figure 3 and 4 show the annual launches, respectively style distribution of our analyzed products *per se*. It will be the subject of our research to test how these two variables react upon population density.

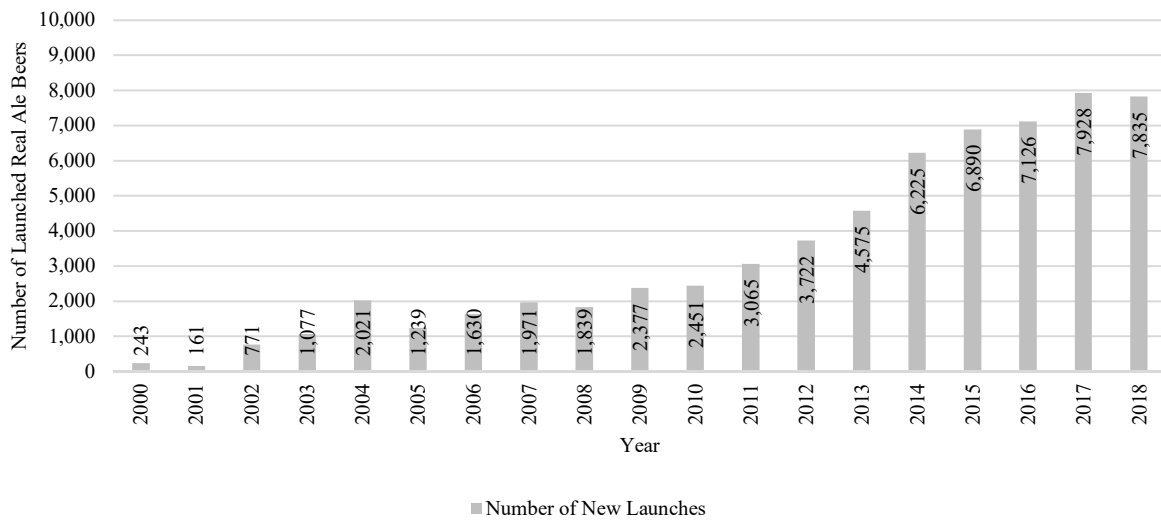


Figure 3 – Number of Launched Real Ale Beers in the United Kingdom (2000 - 2018)

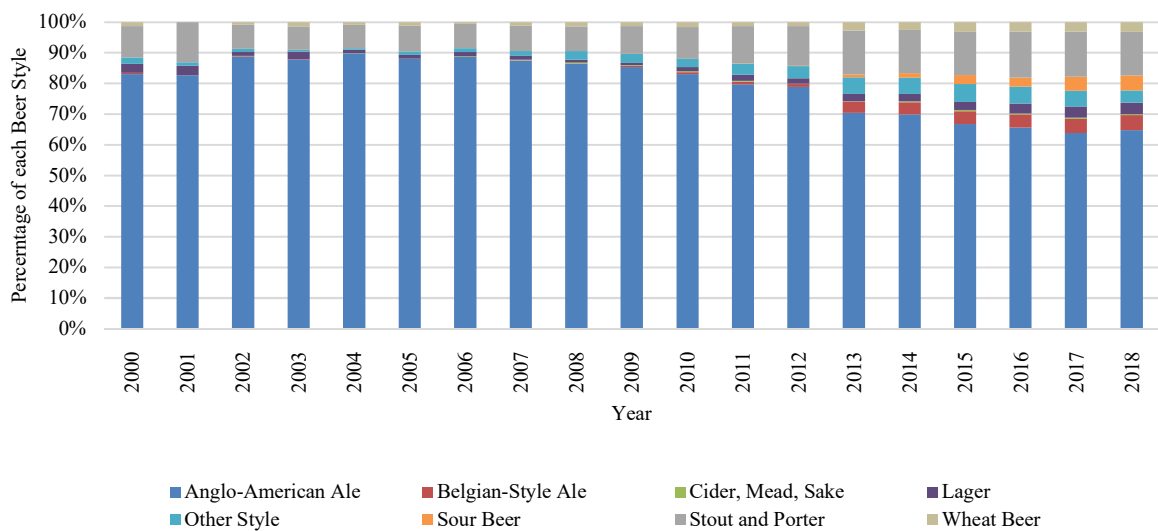


Figure 4 – Style Dispersion of Launched Real Ale Beers in the United Kingdom (2000 - 2018)

As a corollary of the above two charts, we detect that the British real ale market is indeed characterized by a commensurable alteration in the number of market participants and their product scope additions. Yet, it needs to be emphasized that these organizations compete on artisan manufacture, variety, innovation, quality, and genuine local provenance rather than on low prices and advertising that both typify large-scale brewers (CAMRA, 2018b; Danson et al., 2015; Society of Independent Brewers, 2013).

The below maps summarize our above elaborations and imply that the British real ale brewing industry, prevalent in both urban and rural areas, is susceptible to population density. The first two

maps visualize the brewery density in 2000 and 2017, whereas the subsequent two illustrations plot the locations of new beer launches in 2001 and 2018. The comparison of the two sets of mapping gives a direct impression about how firm density links to the likelihood of new product introductions and suggests that the real ale brewing industry in the United Kingdom offers a particularly suitable setting for analyzing and unraveling the effects of firm density on product scope more rigorously.

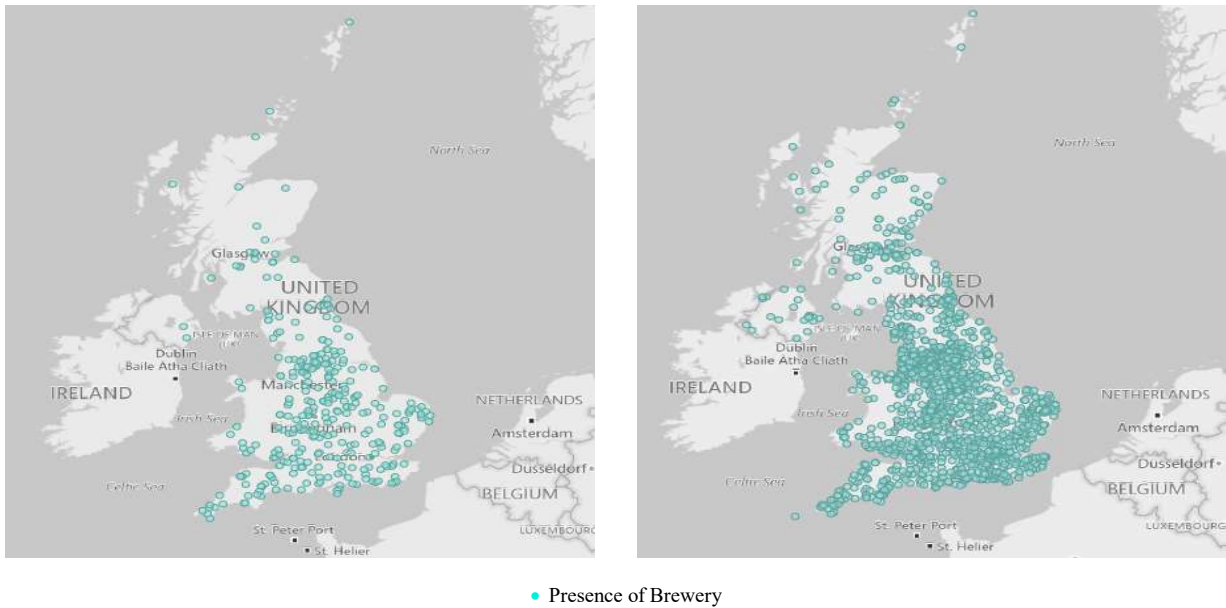


Figure 5 – Geographical Location of Real Ale Breweries in the United Kingdom in 2000 (left) and 2017 (right)

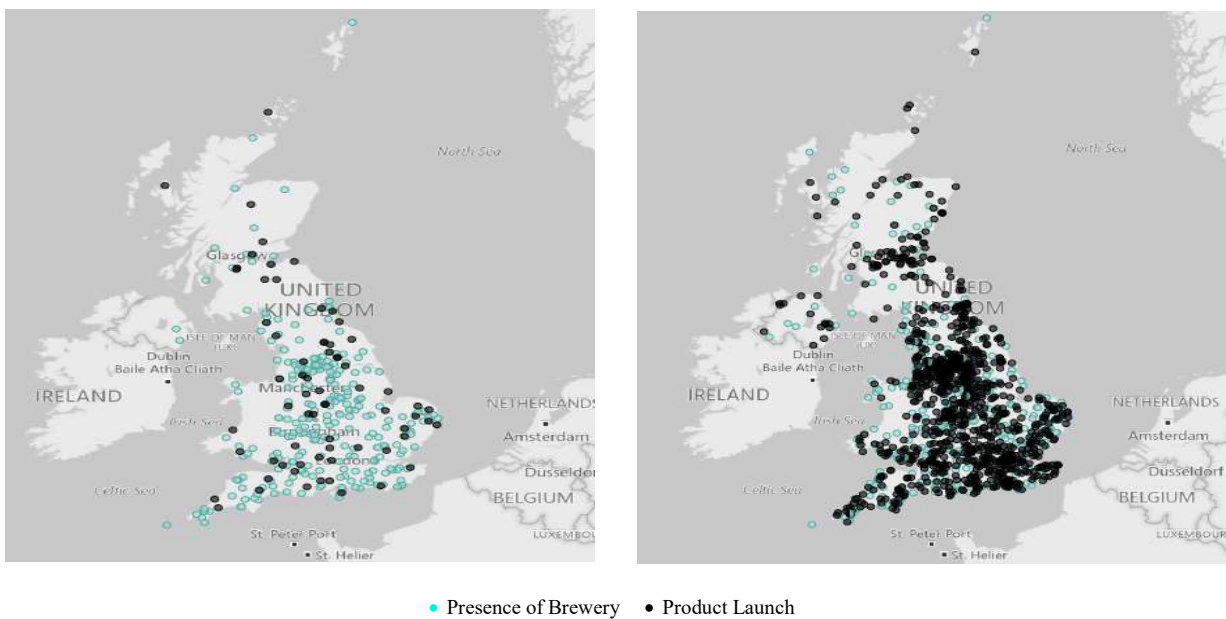


Figure 6 – Geographical Location of Launched Real Ale Beers in the United Kingdom in 2001 (left) and 2018 (right)

## 4.2. Data Sources

To test the expected positive linear relationship between population density and the number, respectively style dispersion of product introductions we deploy two online sources to collect our data and subsequently construct the independent, dependent, and control variables. Our raw firm-level data originate from *The Directory of UK Real Ale Brewers* (Quaffale, 2019), which is a publicly accessible and continuously updated non-profit website that lists the existence of UK-based real ale breweries as well as some of their pivotal business information. These include, besides the brewery's company name, its founding and, if applicable, closing year, its street name, ZIP code and assigned municipality. Occasionally, some pictures and other noteworthy information are provided. To the best of our knowledge, neither firm publicly discloses any (detailed) financial data, making other fundamental performance indicators than a firm's lifetime – like profit or annual expenditures and sales – impossible to systematically obtain.

As of January 20<sup>th</sup>, 2019 *The Directory of UK Real Ale Brewers* offered a sample of 3,112 British real ale breweries for us to investigate. We extracted the above-mentioned data into Microsoft Excel in alphabetical order for additional data transformation. In total, 1,102 breweries had to be eliminated from our further analysis, mainly due to incomplete information on the above mentioned key specifications (720 units). Beyond that, in order to capture name changes of breweries and thus to avoid double counting, we checked our data extract for duplicate ZIP codes.<sup>9</sup> Subsequent case-by-case triangulations with potential hints provided in the directory resulted in additional 129 breweries to be omitted.

To supplement the data of the remaining 2,010 breweries with product-specific details, we utilized *RateBeer* – an American website that introduces itself as “one of the most-visited sources for beer information” (RateBeer, 2019a). The website has not just been mentioned in a range of US-national and international publications (Berlingske Tidende, 2016; Los Angeles Times, 2017; Philadelphia Daily News, 2015; The Independent (UK), 2010), but also got previously applied for other empirical studies in the brewing industry (see for example Clemons (2008); Clemons, Gao, and Hitt

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<sup>9</sup> The structure of each ZIP code in the United Kingdom follows a specific logic of an outward and an inward code that are separated by a single space. The last two characters of the inward code define the so-called postcode unit and represent one or more small user delivery points, like a certain (part of a) street, a single address, or a single or group of properties (Education & Skills Funding Agency, 2018). Thus, ZIP codes evince, within the scope of our possibilities, an almost accurate approach to remove duplicate data entries.



(2006); Frake (2016); Hoeffler, Ariely, West, and Duclos (2013); and Kroezen (2014)). Specifically, RateBeer offers a platform for worldwide craft beer enthusiasts to assess and evaluate one or several beers using a point system, which eventually results in a variety of in-depth product information of an endless number of worldwide breweries available for download and further data modeling. This information includes – among some other, but for our study purpose irrelevant data – the particular product name, beer style, and exact calendar date of the first user rating. For lack of data availability on the precise launch date of each beer, we used the date of the first user rating as a best available proxy to indicate product launch. Consequently, to obtain these data and ultimately find out what kind of and how many beers each and every of these 2,010 real ale breweries produces, we manually entered their name into RateBeer’s search bar that is particularly suited for conducting this and similar requests. We sorted our search results by closest match to circumvent unsuccessful search inquiries, particularly with regard to minor spelling mistakes, omitted name suffixes or prefixes, unnecessary apostrophes, and the like.

Again, all data have been extracted into Microsoft Excel and mapped via basic inbuilt formulas with each individual brewery. We only included those beers in our database that were launched during each brewery’s period of operation. In other words, any beer that was rated for the first time after its brewery ceased operation was removed from further computation and regression analysis. This treatment led to a total of 669 beers (0.8 percent of the original data extract) to be excluded. As a result, a total of 63,146 launched beers between 2000 and 2018 was identified as available for further modeling. The respective styles of these 63,146 products were grouped into eight different categories according to their overall similarity and relatedness as suggested by RateBeer (2019b). These categories are mutually exclusive, meaning that each beer was just grouped into one single style category at each point of time. Their respective proportional distribution over the observation period has been visualized earlier in Figure 4.

We exclusively draw on firm- and product related data for the period from 2000 to 2018 to empirically test the earlier stated hypotheses since RateBeer just went online at the turn of the millennium (RateBeer, 2019a). We perceive these 19 years as large enough time series for obtaining sufficient variability in product scope decisions for the majority of analyzed firms. Our decision is in line with the considerations of other scholars that choose similar or even shorter time spans in their studies and also were able to observe their claimed effects (for research on product scope adjustments see Axaroglou (2008), Barroso and Giarratana (2013), Bayus and Putsis (1999), Sorenson

(2000), Sorenson et al. (2006); for research on population ecology see Carroll and Swaminathan (1992), Mendoza-Abarca, Anokhin, and Zamudio (2015)).

#### 4.3. Construction of Dependent, Independent, and Control Variables

The dependent variables of our two regression models are the number of launched beers for testing product scope breadth (Hypothesis 1) and the style dispersion of launched beers for testing product scope depth (Hypothesis 2). The launch of new products involves different factors, such as the implementation of previous product versions, different labels, variations in alcohol percentage, or the use of a particular flavor. Additionally, the production of different types of beer styles is conducted by applying diverse industrial methods, resources, processes, and know how. We focus our analysis on product scope expansion rather than accumulation as our data do not allow us to clearly capture when a certain beer got withdrawn from the market.<sup>10</sup>

We constructed so-called leads ( $t+1$ ) for the two aforementioned response variables. This forward adjustment by one year is considered as a reasonable alternative to lagging all predictors by the same time period ( $t-1$ ). In doing so, we allow our independent variables sufficient time to take effect upon our two product scope dimensions and thereby prevent cause-and-effect simultaneity.

*Number of Launches:* Building on previous investigations (Bayus & Putsis, 1999; Draganska & Jain, 2005; Sorenson, 2000), we measure a brewery's product scope with the number of beers in its product line. As such, this variable includes the sum of all beers a brewery introduced into the market in a specific year and is directly available in our data extract. As indicated earlier, we assume that a beer got launched in the same year it got reviewed on RateBeer for the first time.

*Style Dispersion of Launches:* The style of launched products is calculated with the so-called Berry Index of Dispersion. By doing so, we follow the research conducted by other scholars, who consider this variable as an exact standard measure of time-variant product dispersion (Barroso & Giarratana, 2013; Giarratana & Fosfuri, 2007).<sup>11</sup> Specifically, the Berry Index of Dispersion

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<sup>10</sup> Albeit the product listings on RateBeer indicate whether a beer has been retired or not, the specific culling date is not provided, which makes it unfeasible for us to utilize this information in our regression.

<sup>11</sup> Other scholars use year dummies (Carroll, Bigelow, Seidel, & Tsai, 1996), min-max difference (Dobrev et al., 2002), or count of the cumulative number of products (Sorenson, 2000) as proxies for capturing product scope differentiation.

reflects if a brewery launched beers in just one or several of the eight possible style categories. It is calculated as follows:

$$\text{Berry Index of Dispersion} = \left[ 1 - \sum_s (N_{ist} / N_{it})^2 \right]$$

where N denotes the number of new beers offered by brewery i in style category s at time t. In contrast to the number of product launches, this measure can assume continuous numbers and ranges from 1 (maximum possible dispersion) to 0 (sales in only one style category, i.e. no product differentiation).

*Distance:* As elucidated, we consider population density as our primary explanatory variable. Consistent with the publications of Hannan and Ranger-Moore (1990) and Baum and Mezias (1992), we operationalize the competitive dimension of population density as the opposite of geographical distance. Therefore, large values for geographical distance imply less intense localized competition and thus less firm density (Hannan & Freeman, 1977).

Explicitly, we compute the Euclidean distance of a focal brewery to all other breweries for each specific year this focal brewery was considered alive. That means that the position of a focal organization i at time t in the given organizational dimension is compared to the position of all other organizations j at time t in the same dimension. Eventually, we are able to weight all active firms according to their proximity to the focal one.

The differences between the focal and each alter organization are transformed to a Euclidean distance as follows:

$$\text{Euclidean Distance} = \sqrt{\sum_{i \neq j} (E_j - E_i)^2 + (N_j - N_i)^2}$$

whereby E represents the easting and N the northing geographic Cartesian coordinates of each firm i and j and where  $i \neq j$ .

In order to apply the above formula, we matched the earlier gathered ZIP codes with their easting and northing coordinates, that we obtained from a publicly available website (Doogal, 2019). To gain a deeper understanding of our data, we also linked each ZIP code to its associated district and county. In case of any matching errors, we concluded that the address information in *The Directory of UK Real Ale Brewers* was outdated. Thus, we retrieved a brewery's latest ZIP code through Google searches, specific beer websites like <https://untappd.com/>, <https://www.beeradvocate.com/>,

<https://beerme.com/>, and <https://www.brewersjournal.info/>, as well as through a brewery's official or Facebook website and eventually performed the above-described calculation.

Visualizing our results in a histogram showed that our raw distance measures were rather skewed. Yet, the measurement of both population density and geographical distance can only adopt positive non-zero values for different organizations  $i$  and  $j$ . As such, we are able to apply the natural logarithm on all calculated distance values and thus obtain more evenly distributed, but at the same time lower-scale distance values.

In addition to *Distance*, we also consider a variety of other independent variables, that have been used by previous scholars to explain product range adaptations more broadly. In particular, we introduce a relatively comprehensive set of control variables capturing both firm- and market-related factors to prevent the effects of population density on product scope from occurring spuriously.

*Cumulative Number of Beers:* The cumulated number of products in the market offered by each brewery is used as a control variable to predict their presumable product introductions. According to existing literature on multiproduct firms, exploiting any prevalent excess resources from current offerings towards additional products is an efficient way for firms to organize economic activity (Teece, 1980). Similarly, a firm's existing intangible resources enable organizational growth and diversification (Montgomery, 1995), whose quality and capacity are further enhanced through already gained experience in the market (Dierickx & Cool, 1989; Levinthal, 1995).

The firm-based measurement is calculated for each year by summing all listed products on Rate-Ber that have been reviewed so far. Possible subsequent yearly adjustments of this variable mirror, by consequence, any previous product scope additions.

*Style Dispersion of Cumulated Beers:* Consistent with the preceding elaborations on the relationship between organizational learning and product scope proliferation, we use a brewery's hitherto marketed product styles as a predictor for its future product variety. That means, a brewery that already produces beers in several style categories has already accumulated contextual knowledge on style-specific activities, which can be easily assimilated and exploited towards new products (Cohen & Levinthal, 1989). Consistent with our approach to calculate the style dispersion of new launches, we calculate the Berry Index of Dispersion here too with  $N$  now denoting the number of cumulated beers.

*Herfindahl-Hirschman Index:* Prior research argues, that the level of industry concentration should affect a firm's likelihood to offer new products in the market. In particular, it has been claimed that incumbent firms respond stronger to any new entrant when the level of industry concentration increases (Clarke, Davies, & Waterson, 1984). Accordingly, under this scenario it gets more challenging for any individual firm to further expand its prevalent product line (Putsis & Bayus, 2001).

We measure the annual industry concentration with the Herfindahl-Hirschman Index, which is calculated by summing the squared market share of each firm, whereby market share is, due to data limitations on sales figures, contingent on the firm's number of cumulated products in the market. Our computation results in 19 distinct yearly concentration measures ranging from 0.003 to 0.275, thereby signaling the earlier visualized high competition in our analyzed market.<sup>12</sup>

*Market Size:* Our two regression models also attempt to control for an organization's reactions to its surrounding customer base. A higher (human) population density in a specific region implies a larger market size and also a higher market attractiveness as access to potential customers increases. Relating thereto, firms operating in these geographical areas are exposed to heterogeneous consumer preferences that they are eager to satisfy (Chen, Jiao, & Tseng, 2009; Gatignon, Weitz, & Bansal, 1990; Shankar, 2006). Therefore, we derive the geographical distribution of consumers from an official report published by The Office for National Statistics (2017) on population estimates for each local authority in the United Kingdom for the years 2001 to 2017, which we subsequently integrate into our database.<sup>13</sup> The earlier obtained information on a brewery's district and county proved to be very helpful for this task.

*Firm Age:* Our data extract includes a wide array of real ale breweries, ranging from well-established to very young firms. Consistent with the findings in previous literature, we deem it important to control for age-dependent impacts of change on product scope expansion. In fact, many scholars claim that an organization's age can influence the causes of its organizational change. Specifically, Hannan and Freeman (1984) predict that older organizations are less likely to change, as prevalent

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<sup>12</sup> The index could become as low as 0.000 for perfect competition. By contrast, a value of 1.000 indicates a monopolistic market.

<sup>13</sup> Unfortunately, we could not find a more refined publication that splits the absolute numbers of residents into different age categories, thus preventing us from excluding considerably young or elderly residents.

organizational relationships and practices become institutionalized and eventually result in inertia. In accordance with this theory, a variety of studies on different industries discovers that organizational change is less prevalent among older organizations (Delacroix and Swaminathan (1991) on wineries; Baron, Mittman, and Newman (1991) on state agencies; Miller and Chen (1994) on airlines; Halliday, Powell, and Granfors (1993) on state bar associations; Amburgey, Kelly, and Barnett (1993) on Finnish newspaper publishing organizations).

We measure each brewery's tenure in the market as the difference between the particular year of investigation and the year the firm started its operations. For reasons of simplicity and due to lack of precise disclosures of each brewery's founding date, we assume that operations began on January 1<sup>st</sup> and ceased on December 31<sup>st</sup> each year. According to this full-year consideration, a brewery that, for instance, started its operations in the year 2008 was three years old in the year 2010.

*Relative Firm Size:* Contrary to the findings on organizational age, studies on inertia and organizational size show mixed results. Hannan and Freeman (1984) argue that a firm's size may hinder its ability to change and results in higher failure when attempting to do so. Although some empirical findings confirm this theory (Baron et al., 1991; Delacroix & Swaminathan, 1991; Halliday et al., 1993), other scholars could prove a positive relationship between organizational size and probability of change (Haveman, 1993; Huber, Sutcliffe, Miller, & Glick, 1993).

Consistent with the earlier mentioned caveat of lacking data on sales volume, assets, number of employees, or other organizational data, we define a brewery's organizational size according to its product line length. Specifically, we measure a firm's relative size as its cumulated number of offered products in each year in relation to the highest number of products a single brewery offered in the same year. Consequently, our calculated variable ranges from almost 0 (shortest relative product line) to 1.00 (longest relative product line). Following Barnett and Freeman (2001), we believe that this approach enables us to mirror an organization's size in a rough, albeit not ideal way.

*Year:* We account for temporal variances in our data by incorporating year dummies in all our regression models.

Summarizing the above elaborations, our final dataset comprises longitudinal firm- and product level data of real ale breweries in the United Kingdom operating at any time between 2000 and 2018. The unit of analysis is at the firm-level. Specifically, for each brewery the database contains

the number of product introductions as well as the style categories in which an organization offered products in its initial and each subsequent year of operation. This information is supplemented with a measurement for geographical distance as the inverse of population density, data on a firm's cumulated product line, information on organizational characteristics, and market-based specifications capturing industry concentration and customer base.

These cross-sectional time-series data will allow us to investigate how a firm's product scope proliferation strategy is contingent on the number of its surrounding competitors. We therefore set up the following two regression models:

The full model for testing Hypothesis 1:

*Number of Launches (Lead)*

$$\begin{aligned} &= \beta_0 + \beta_1 \text{Distance (ln)} + \beta_2 \text{Cumulative Number of Beers} \\ &+ \beta_3 \text{Herfindahl - Hirschman Index} + \beta_4 \text{Market Size} \\ &+ \beta_5 \text{Relative Firm Size} + \beta_6 \text{Firm Age} + \beta_7 \text{Year} \end{aligned}$$

The full model for testing Hypothesis 2:

*Style Dispersion of Launches (Lead)*

$$\begin{aligned} &= \beta_0 + \beta_1 \text{Distance (ln)} + \beta_2 \text{Number of Launches} \\ &+ \beta_3 \text{Style Dispersion of Cumulated Beers} + \beta_4 \text{Herfindahl} \\ &- \text{Hirschman Index} + \beta_5 \text{Market Size} + \beta_6 \text{Relative Firm Size} \\ &+ \beta_7 \text{Firm Age} + \beta_8 \text{Year} \end{aligned}$$

The descriptive statistics of and correlations between the aforementioned variables are presented in Table 1 for Hypothesis 1 and Table 2 for Hypothesis 2 (both on page 32). We regressed 12,598 density-year observations of 1,908 real ale breweries to predict the relationship between population density and number of product introductions. Similarly, we measured the effect of 9,445 density-year observations of 1,744 real ale breweries on their launched product styles. Both tables reveal that the majority of our utilized variables are not highly correlated, but capture different factors influencing product scope adjustments. Except of *Herfindahl-Hirschman Index*, all predictor variables are positively related to the number of product introductions (Hypothesis 1). The style of product introductions, in contrast, is not just adversely affected by the prevalent industry concentration, but also by an organization's age (Hypothesis 2).

Both summary statistics indicate that our investigated sample shows an appropriately high heterogeneity on all constructed dependent and independent variables and thus confirm their eligibility for testing our two hypotheses. First, British real ale breweries launched, on average, 4.392 beers (s. d. = 7.814) in a fairly few style categories (mean of style dispersion = 0.212) across the observation period, delineating that dispersed product styles are a common, yet just to a moderate extent followed business practice within the British real ale brewing industry. Second, our analyzed firms diverge quite substantially in terms of their organizational size and age as well as their cumulated number of products. Third, the degree of industry concentration as well as the size of the respective customer markets these organizations launch onto vary to a considerable degree.

However, three interrelations deserve some further elaboration. First, we stress that both overviews solely report *pairwise* correlations and thus ignore any potential impact of the other variables, which might result in some misleading correlations. For instance, while both correlation tables show that *Distance (ln)* and each dependent variable are positively correlated with each other, it remains to be seen if this relationship still holds after taking the contributions of our selected control variables into account. Moreover, the cumulated number of products is moderately high ( $r = 0.565$ ) correlated with the number of new launches. Apart from that, we highlight the strong positive ( $r = 0.724$ ) relationship between the number of cumulated products and an organization's size in Table 1, which stems from our chosen approach to compute the latter one.

Especially in light of these, but also of other possible correlations, we calculate the Variance Inflation Factors (VIFs) for all variables in order to diagnose potential multicollinearity. The VIF scores of our predictor variables used to test our first hypothesis range from 1.02 to 3.23 with a mean of 1.97 and for the second hypothesis from 1.09 to 1.77 with a mean of 1.46. Both averages are far below the critical threshold value of 10, signaling that the extent of correlation between one explanatory variable and the other explanatory variables is acceptable and that we are indeed able to accurately assess the contribution of each predictor in our two models.



Table 1 – Summary Statistics and Correlation Matrix for Variables Used to Test Product Scope Breadth (Hypothesis 1)

VARIABLES	N	Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7
1 Number of Launches (Lead)	12,598	4.392	7.814	0.000	158.000	1.000						
2 Distance (ln)	12,598	19.259	0.503	17.939	21.071	0.048	1.000					
3 Cumulative Number of Beers	12,598	23.005	34.226	1.000	638.000	0.565	0.145	1.000				
4 Herfindahl-Hirschman Index	12,598	0.003	0.002	0.002	0.018	-0.038	-0.595	-0.160	1.000			
5 Market Size	12,598	978.193	1,821.036	8.000	15,818.000	0.236	0.038	0.107	-0.076	1.000		
6 Relative Firm Size	12,598	0.090	0.117	0.002	1.000	0.446	-0.250	0.724	0.219	0.021	1.000	
7 Firm Age	12,598	17.598	44.326	1.000	618.000	0.004	-0.073	0.153	0.132	-0.032	0.265	1.000

Table 2 – Summary Statistics and Correlation Matrix for Variables Used to Test Product Scope Depth (Hypothesis 2)

VARIABLES	N	Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8
1 Style Dispersion of Launches (Lead)	9,445	0.212	0.249	0.000	0.832	1.000							
2 Distance (ln)	9,445	19.240	0.505	17.939	21.062	0.249	1.000						
3 Number of Launches	9,445	5.348	7.868	0.000	149.000	0.309	0.101	1.000					
4 Style Dispersion of Cumulated Beers	9,445	0.260	0.206	0.000	0.828	0.377	0.354	0.289	1.000				
5 Herfindahl-Hirschman Index	9,445	0.003	0.002	0.002	0.018	-0.152	-0.594	-0.101	-0.206	1.000			
6 Market Size	9,445	1,068.736	1,965.469	8.000	15,818.000	0.220	0.069	0.232	0.212	-0.092	1.000		
7 Relative Firm Size	9,445	0.107	0.128	0.002	1.000	0.058	-0.249	0.506	0.011	0.210	0.002	1.000	
8 Firm Age	9,445	17.930	43.237	1.000	612.000	-0.056	-0.087	0.008	-0.066	0.152	-0.042	0.307	1.000

## 5. Analysis of Regression Results

### 5.1. Main Analysis

We run all regression models in version 15.0 of the statistical software Stata. In doing so, we primarily use the tools provided in the *xt*-series of commands for investigating the proposed relationships of our panel data.

As our dependent variable of Hypothesis 1 only assumes count values, we apply negative binomial regression to test the impact of population density on the number of product introductions by British real ale breweries over the 19-year observation period. Negative binomial regression allows two options for estimating unobserved effects within panel data: Random- and fixed-effects models. A random-effects model is appropriate in situations where the intercept of each cross-sectional unit is *uncorrelated* with the regressors in all time periods and thus reflects a randomly varying dispersion among the analyzed groups. We incorporate random-effects estimators in our regression model of Hypothesis 1 as we are interested in inspecting heterogeneity *across* the real ale breweries in our dataset.

Table 3 (on page 35) reports the random-effects regression estimates of Hypothesis 1. Model 1 provides the baseline regression model by solely including the effects of all control variables on the number of product launches. The predictors are consistently highly significant at  $p < 0.01$ , except for *Firm Age* that is only significant at  $p < 0.05$ . The level of industry concentration ( $\beta = 17.683$ , s.e. = 5.292), the size of an organization ( $\beta = 905.462$ , s.e. = 111.318), the market it introduces its products into ( $\beta = 0.064$ , s.e. = 0.009) as well as its cumulated product scope ( $\beta = 1.662$ , s.e. = 0.274) positively impact a brewery's likelihood to expand its product scope even further. These observed relationships are consistent with the findings of previous papers (Gatignon et al., 1990; Haveman, 1993; Huber et al., 1993; Shankar, 2006). Conversely, older firms ( $\beta = -1.171$ , s.e. = 0.514) are less likely to adjust their current product scope, thus ratifying Hannan and Freeman's (1984) conceptualization of organizational inertia.

Model 2 examines Hypothesis 1 by including the logarithmized Euclidean distance in the regression model. All control variables – except for *Herfindahl-Hirschman Index* ( $p = 0.807$ ) – remain statistically significant, implying that a more concentrated industry environment is not highly associated with product launch decisions, which contradicts the findings of other scholars (Clarke et al., 1984; Putsis & Bayus, 2001). *Distance (ln)* is substantially significant ( $p = 0.005$ ) and assumes a negative arithmetic sign ( $\beta = -211.170$ , s.e. = 74.704), which suggests that organizations

are less likely to introduce new products as distance increases. More precisely, as the geographical distance ( $\ln$ ) rises by 1 standard deviation ( $= 0.503$ ), the number of product launches falls, on average, by  $0.899 (= e^{((-211.170 / 1000) \times 0.503)})$ . By the same token, a high population density makes firms, on average, more likely to increase their product scope breadth, leading to a proof of Hypothesis 1. The decreasing marginal effect of *Distance ( $\ln$ )* on the number of product launches is depicted in Figure 7 below.

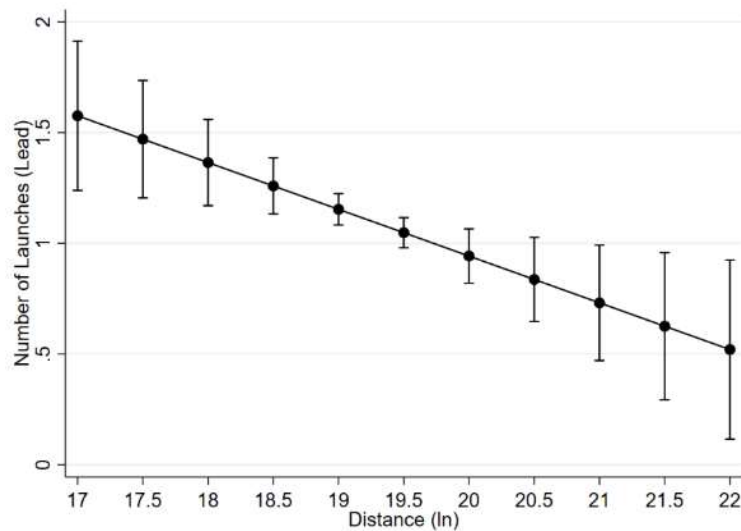


Figure 7 – Marginal Linear Effect of Distance ( $\ln$ ) on Number of Product Launches (Hypothesis 1) with 95% Confidence Interval

In Model 3 we introduce a squared term of *Distance ( $\ln$ )* in order to further enhance our understanding of the relationship between population density and production scope breadth. In particular, this additional variable allows us to investigate the pattern of their interrelation more closely. We will discuss the regression results in our additional analysis in section 5.2. and disclose if a linear or curvilinear regression line suits Hypothesis 1 more appropriately.

Table 3 – Regression Results for Product Scope Breadth (Hypothesis 1) with Random-Effects Negative Binomial Regression

VARIABLES	Number of Launches (Lead)		
	Model 1	Model 2	Model 3
Distance (ln) <sup>2</sup> <sup>α</sup>			255.136*** (37.417)
Distance (ln) <sup>α</sup>		-211.170*** (74.704)	-10,135.730*** (1,460.030)
Cumulative Number of Beers <sup>α</sup>	1.662*** (0.274)	1.679*** (0.275)	1.732*** (0.272)
Herfindahl-Hirschman Index	17.683*** (5.292)	-2.151 (8.791)	-23.836 (9.553)
Market Size <sup>α</sup>	0.064*** (0.009)	0.061*** (0.009)	0.062*** (0.009)
Relative Firm Size <sup>α</sup>	905.462*** (111.318)	890.580*** (111.408)	893.755*** (110.964)
Firm Age <sup>α</sup>	-1.171** (0.514)	-1.125** (0.513)	-0.972* (0.518)
Constant <sup>α</sup>	725.284*** (47.843)	4,940.354*** (1,492.364)	101,465.500*** (14,285.940)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	12,598	12,598	12,598
Number of Real Ale Breweries	1,908	1,908	1,908

Standard Errors in Parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

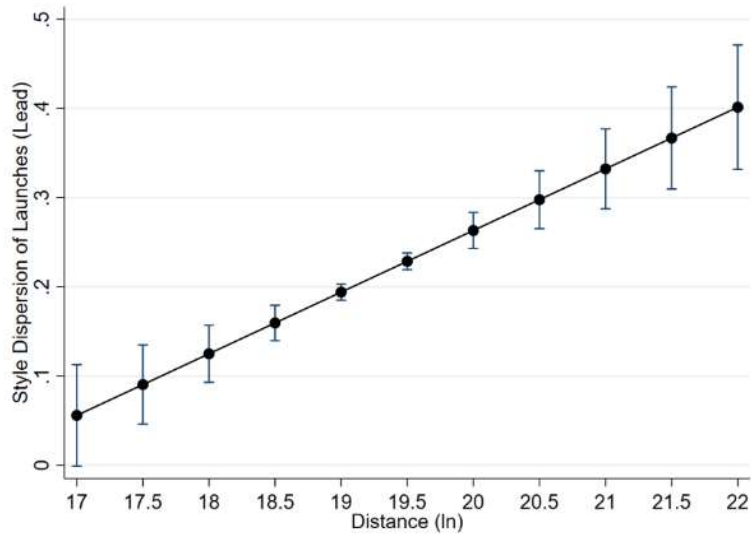
<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

Unlike in Hypothesis 1, our response variable in Hypothesis 2 can assume any type of value between 0 and 1, which makes it possible to use panel data regression to fit the proposed regression model. Again, we include random-effects specifications for the reason mentioned earlier. The regression estimates are presented in Table 4 on page 38.

Models 4 and 5 investigate Hypothesis 2 by considering which covariates affect the style dispersion of product introductions – with and without including the effect of *Distance (ln)*. Model 4 presents the baseline analysis with only control variables and shows that all measurements – with the exception of *Firm Age* ( $\beta = -0.168$ , s.e. = 0.094), *Relative Firm Size* ( $\beta = -80.860$ , s.e. = 31.216), and *Herfindahl-Hirschman Index* ( $\beta = -2.709$ , s.e. = 1.497) – assume a positive arithmetic sign and are in line with those in Model 1, thereby mainly confirming the findings of the previously mentioned studies. Moreover, the level of industry concentration and organizational age are only significant at  $p < 0.1$ , whereas the remaining predictors are already significant at  $p < 0.01$ .

When including the logarithmized distance measure in Model 5, a brewery's age and its relative firm size become significant at a 5% level, with the significance level of the other covariates being unchanged compared to the baseline model. As such, all introduced control variables do impact the style dispersion of a brewery's launched products when capturing the impact of population density. The p-value of *Distance (ln)* is highly significant ( $p < 0.01$ ) and *Distance (ln)* does positively affect the product style variety of real ale breweries ( $\beta = 69.148$ , s.e. = 12.859). In other words, as the geographical distance (ln) increases by 1 standard deviation (= 0.505), the style dispersion of product launches increases, on average, by 0.035 (=  $(69.148 / 1000) \times 0.505$ ). Consequently, a high population density has a negative effect on the style dispersion of new products, thus not supporting Hypothesis 2. The overall  $R^2$  of our model lies at 20.61%, resulting in an acceptable goodness of fit of our chosen regression model. The increasing marginal effect of *Distance (ln)* on the style dispersion of product launches is plotted in Figure 8 on the next page.

Equivalently to Model 3 for Hypothesis 1, we also include the ln-transformed squared term of the distance variable in Model 6 to investigate the pattern of the regression line more thoroughly. The results will be discussed in section 5.2., too.



*Figure 8 – Marginal Linear Effect of Distance (ln) on Style Dispersion of Product Launches (Hypothesis 2) with 95% Confidence Interval*

Considering the results of our two regressions and against the background of the geographical maps plotted earlier, we draw the preliminary conclusion that an organization’s product scope does, indeed, evolve in response to population density. Yet, the observed effects do just partially correspond to our claimed hypotheses.

Table 4 – Regression Results for Product Scope Depth (Hypothesis 2) with Random-Effects Panel Regression

VARIABLES	Style Dispersion of Launches (Lead)		
	Model 4	Model 5	Model 6
Distance (ln) <sup>2</sup> <sup>α</sup>			26.786*** (9.933)
Distance (ln) <sup>α</sup>		69.148*** (12.859)	-974.647** (387.219)
Number of Launches <sup>α</sup>	6.248*** (0.420)	6.255*** (0.419)	6.215*** (0.419)
Style Dispersion of Cumulated Beers <sup>α</sup>	163.010*** (14.462)	153.979*** (14.554)	153.270*** (14.550)
Herfindahl-Hirschman Index	-2.709* (1.497)	3.620* (1.902)	1.308 (2.084)
Market Size <sup>α</sup>	0.016*** (0.002)	0.018*** (0.002)	0.018*** (0.002)
Relative Firm Size <sup>α</sup>	-80.860*** (31.216)	-69.456** (31.193)	-66.627** (31.158)
Firm Age <sup>α</sup>	-0.168* (0.094)	-0.193** (0.094)	-0.188** (0.094)
Constant <sup>α</sup>	152.384*** (10.151)	-1,225.529*** (256.345)	8,944.741** (3,779.116)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	9,445	9,445	9,445
Number of Real Ale Breweries	1,744	1,744	1,744

Standard Errors in Parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

## 5.2. Additional Analysis

We employ several extensions to our main analysis to check the sensitivity of our obtained results and elucidate them hereinafter. First and foremost and as already indicated, we introduced a quadratic term of *Distance (ln)* in each regression model to gain a more accurate picture of the shape of the regression line visualizing the proposed connection between population density and product scope. This added non-linearity results in the following two adapted equations:

The (adjusted) full model for testing Hypothesis 1:

*Number of Launches (Lead)*

$$\begin{aligned} &= \beta_0 + \beta_1 \text{Distance (ln)} + \beta_2 \text{Distance (ln)}^2 \\ &+ \beta_3 \text{Cumulative Number of Beers} + \beta_4 \text{Herfindahl – Hirschman Index} \\ &+ \beta_5 \text{Market Size} + \beta_6 \text{Relative Firm Size} + \beta_7 \text{Firm Age} + \beta_8 \text{Year} \end{aligned}$$

The (adjusted) full model for testing Hypothesis 2:

*Style Dispersion of Launches (Lead)*

$$\begin{aligned} &= \beta_0 + \beta_1 \text{Distance (ln)} + \beta_2 \text{Distance (ln)}^2 + \beta_3 \text{Number of Launches} \\ &+ \beta_4 \text{Style Dispersion of Cumulated Beers} + \beta_5 \text{Herfindahl} \\ &- \text{Hirschman Index} + \beta_6 \text{Market Size} + \beta_7 \text{Relative Firm Size} \\ &+ \beta_8 \text{Firm Age} + \beta_9 \text{Year} \end{aligned}$$

As depicted in Figure 9 on the following page, the number of product introductions initially falls as *Distance (ln)* increases. Likewise, Figure 10 displays that the style dispersion of new products at first slightly decreases as *Distance (ln)* rises. After the respective turning point in both regression graphs, the outcome variable increases again as *Distance (ln)* increases.

We follow previous studies (Plassmann & Khanna, 2007) to obtain each regression curve's exact turning point. Accordingly, we determine that the minimal number of product introductions in Figure 9 is attained at a geographical distance (ln) of 19.863 ( $= -(-10,135.730 / 2 \times (255.136))$ ). After this point is exceeded, product scope additions start to increase again as *Distance (ln)* continues to rise. Equivalently, the style dispersion of launched products is at its lowest at a geographical distance (ln) of 18.193 ( $= -(-974.647 / 2 \times (26.786))$ ). Beyond that point, the style of launched products is more dispersed. The squared terms in both regression models (Model 3 and Model 6)



are highly significant ( $p < 0.01$ ), thus confirming the illustrated curvilinear pattern between population density and product breadth and product depth, respectively.

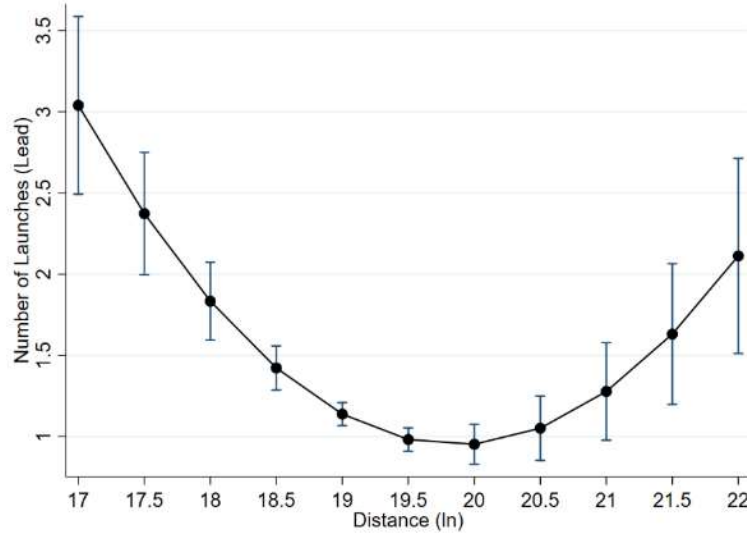


Figure 9 – Marginal Curvilinear Effect of Distance (ln) on Number of Product Launches (Hypothesis 1) with 95% Confidence Interval

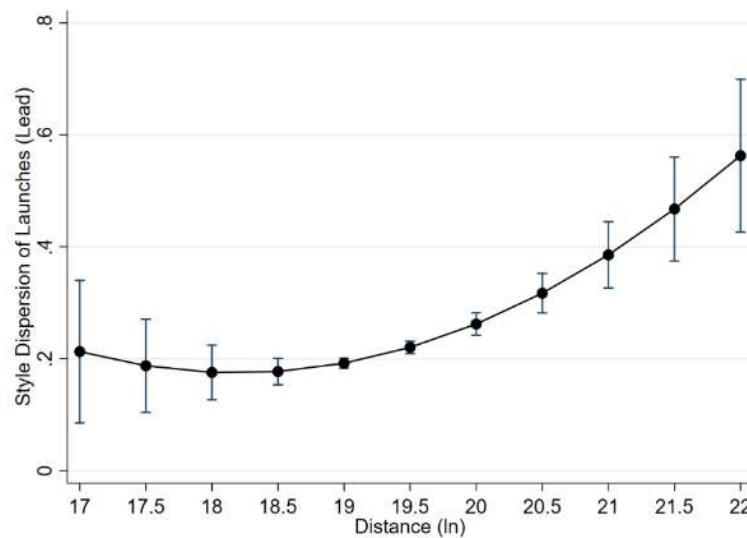


Figure 10 – Marginal Curvilinear Effect of Distance (ln) on Style Dispersion of Product Launches (Hypothesis 2) with 95% Confidence Interval

To check the consistency of our results, we carry out a variety of additional regression analyses. First, we conduct the Hausman specification test (1978) to formally test for statistically significant differences in the coefficients on the time-varying explanatory variables (full model) of Hypothesis 1 and 2. The respective underlying null hypothesis states that the coefficients estimated by fixed-

effects and random-effects estimators do not substantially differ. As the Hausman test rejected the need for random effects at  $p < 0.001$ , we re-run our two regression models with fixed-effects estimators. A fixed-effects model assumes that the individual-specific intercept may be *correlated* with one or more regressors. It therefore accounts for unobserved firm-level heterogeneity and in doing so reflects unique features of the individual breweries.

Although the inclusion of fixed-effect estimators led to the removal of 551 observations for Hypothesis 1, all coefficients, but *Market Size*, retain their respective algebraic sign when including *Distance (ln)* as predictor variable (Model 8). However, both *Firm Age* ( $p = 0.234$ ) and *Market Size* ( $p = 0.721$ ) are now – in addition to *Herfindahl-Hirschman Index* ( $p = 0.317$ ) – highly insignificant compared to our initial model with random-effects estimators (Model 2). These results imply that the number of new product launches is not sensitive to these variables when taking unobserved firm-level heterogeneity into account. Most importantly, the ln-transformed distance variable ( $\beta = -409.898$ , s.e. = 108.750) does also with fixed-effects estimators adversely impact the number of product introductions and is still significant at a 1% level. Furthermore, the quadratic term in Model 9 remains significant at  $p < 0.01$ , giving proof for a non-linear pattern. Further details can be obtained in Appendix 1.

Testing Hypothesis 2 with fixed-effects estimators leads to a different scenario. Besides the level of industry concentration ( $p = 0.485$ ) and organizational size ( $p = 0.644$ ), the geographical distance (ln) ( $p = 0.120$ ) fails to become significant at all commonly used significance levels (Model 11). Yet, its quadratic term in Model 12 is highly significant at  $p < 0.01$ , thus validating the curvilinear relationship. Additional information is displayed in Appendix 2.

While the earlier described VIF tests already provided initial evidence that multicollinearity is not a major concern in any of our two regressions models, we nevertheless exclude *Relative Firm Size* from both regression models to account for its strong correlation to *Cumulative Number of Beers* and subsequently re-estimate our regression models. Appendix 3 and 4 report the adjusted regression results for Hypothesis 1 and 2, respectively. Comparing the updated predictors with those in the initial models does not lead to any new or noteworthy findings. Specifically, eliminating the effect of organizational size on either response variable leads to quite consistent findings, in terms of mathematical signs and statistical significance of all, but one explanatory variable. *Firm Age* ( $p = 0.612$ ) becomes non-significant when including our distance measure in Hypothesis 1 (Model 14), suggesting that both organizational size and age in combination are important predictors of product breadth. Apart from that, the linear (Model 14 and 17) and squared term (Model 15 and

18) of *Distance (ln)* affect the number and style dispersion of product scope expansion in the same direction and with the same statistical significance level as in the main regression models, thus confirming the robustness of our original models.

To further corroborate our obtained results for Hypothesis 1, we also regress our panel data using zero-inflated negative binomial regression, which accounts for the excess zeros evident in our dataset by running different probability models for zero and non-zero counts (Appendix 5). In total, there were 3,153 incidents (roughly one quarter of all observations) in which breweries did not launch any new product, albeit being operative at a certain point of time. While the direction of all explanatory variables is mainly (with the only exception of *Herfindahl-Hirschman Index*) confirmed when including the logarithmized distance measure in Model 20, this distance variable is only significant in its squared term version (Model 21). Beyond that, explicitly considering zero-inflated values lets *Firm Age* become more significant (from  $p < 0.1$  to  $p < 0.01$ ).

To verify our findings for Hypothesis 2, we replace our initially selected dependent variable *Style Dispersion of Launches (Lead)* with *Number of Different Launched Styles (Lead)*, thus reflecting style not in a continuous concentration but in an integer response variable. We constructed this alternative measure by summing all different style categories that a firm's product launches fell into in a particular year. The regression results obtained from this modification are summarized in Appendix 6. Despite some deviations in the p-value of *Firm Age* (Model 22 to 24) and changing magnitudes of our coefficients, all significance levels and arithmetic signs remain unchanged when substituting the originally chosen dependent variable with a similar one. We conclude therefore that this alternative approach corroborates the validity of our findings for Hypothesis 2.

As every beer launch, naturally, entails a style and hence both variables are correlated ( $r = 0.644$ ), we adjust the above regression model by constraining *Number of Different Launched Styles (Lead)* to be larger than 1 (Appendix 7) as a final additional test of our second hypothesis. Re-estimating the regression with this restriction validates the significance of *Distance (ln)* only in its linear version (Model 26). All control variables, but *Firm Age*, remain significant when a firm adds multiple products to its product scope (Model 26 and 27).

Altogether, we find sufficient confirmation in our applied robustness checks for our two originally proposed regression models. The majority of our adaptations supports our initial findings by yielding similar regression results – concerning direction and significance levels – for both hypotheses. In particular, the quadratic ln-transformed distance variable proves to be statistically

significant in all investigated cases, thus leading to highly consistent results for the non-linear regression model.

## **6. Discussion**

The main argument raised in this paper is that population density is a substantial determinant of product scope adaptations. We contended that competitive forces play a preponderant role in shaping the strategic behavior of incumbent firms in mature industries and thus deliberately restricted our study to a market at this stage of development. Specifically, we borrowed arguments from different streams of research focusing on the interrelation between competition and innovation and proposed that a high population density positively impacts an organization's product breadth and depth – represented by the number and style dispersion of its launched products, respectively.

Examining a comprehensive sample of 2,010 real ale breweries in the United Kingdom operating any time between 2000 and 2018, our results revealed that population density indeed influences an organization's product scope decision. In particular, we proved that a high population density makes British real ale breweries to increase their product scope breadth by introducing additional products onto the market. We did, however, not find evidence that a high population density positively impacts the style dispersion of new launches. Au contraire, our results demonstrated that real ale breweries are less likely to increase their product scope depth as population density increases. Besides isolating other aspects potentially influencing an organization's choice for product scope expansion in our control variables, we applied a variety of post-hoc analyses to accurately estimate the two respective relationships between our main variables and by this confirm the robustness of our findings.

Empirically validating that population density is an important predictor of product introductions within the British real ale brewing industry leads to some interesting and important implications for both theory and practice, that will be thoroughly discussed hereinafter. In doing so, we will carefully contextualize our findings within the literature reviewed earlier by showing how our result for Hypothesis 1 agrees with previous studies and by elaborating on our unanticipated result for Hypothesis 2.

### 6.1. Contributions to Literature

First, we analyze how exactly organizations adjust their product scope in light of a changing population density and by that contribute to the prevalent literature on product scope proliferation strategies. In particular, we highlight that firms combine the two facets of product breadth and product depth in a diverging way in their launch strategies when responding to altering population density and thus contribute in enhancing our understanding of product scope proliferation at the firm level. In fact, previous literature has to a large extent focused on the overall benefits and detriments of a certain product line's length and diversification and in this context mainly analyzed their implications on performance (Li & Greenwood, 2004; MacDuffie et al., 1996; Tanriverdi & Lee, 2008), yet has so far ignored the moderating effect of population density on these two dimensions of product scope change. Put in a methodological way, other scholars primarily regard one or several aspects of an organization's product scope as explanatory variables, whereas we switch the perspective and regard product scope as a response variable. Beyond that, the significance of our chosen control variables verifies existing research on other essential determinants of product scope, like organizational characteristics and market-related factors (Bayus & Putsis, 1999; Hannan & Freeman, 1984; Putsis & Bayus, 2001).

To build our argumentation, we explored different philosophies explaining the relationship between innovation and competition by comparing their respective assumptions and predictions. In doing so, we aimed to clarify any inconsistency by *integrating* these different perspectives in our research to eventually understand how competition influences product scope change. More specifically, we investigated two different forms of innovation – new product launches and new industrial processes – and used an ecological perspective to understand the rationale behind their spread.

We find that organizations adopt different competitive behaviors depending on the type of organizational innovation. In particular, our study shows that launches of new products are positively related to population density. While still moved by the ambition to gain market dominance, organizations take environmental factors into consideration when choosing the extent to which product introductions are appropriate. Prior research confirms, for example, that firms can use long product lines as a means to protect themselves against proliferating competitors (Bhatt, 1987; Gilbert & Matutes, 1993). Other reasons include improving the company's attractiveness for customers (Barnett & Freeman, 2001) as well as increasing its sales volume and market share (Kadiyali et al.,

1998; Kekre & Srinivasan, 1990). This supports Hypothesis 1, which claimed that organizations tend to increase the number of product launches as the geographical concentration of rivalry increases. Specifically, a real ale brewery's product scope follows a U-shaped pattern when reacting upon population density: Our examined firms are, on average, least likely to expand their current product scope at a medium concentration of closeby rivals. After a geographical distance (ln) of 19.863, though, they choose to add more products to their current product line and thereby presumably utilize existing brand names and technology and create synergies among their operational and managerial activities (Gimeno & Woo, 1999; Li & Greenwood, 2004; Tanriverdi & Lee, 2008).

Surprisingly, we do not find support for Hypothesis 2 that argued for a positive relationship between dispersion of beer styles and population density. As visualized earlier, we find that the marginal effect of population density on a product line's style dispersion follows a curvilinear pattern, too. Real ale breweries tend to *narrow* their product variety as population density increases, with the lowest style dispersion at a geographical distance (ln) of 18.193. After this point, the likelihood of introducing more dispersed products styles rises slightly as breweries start again to increase the number of industrial processes or methods for producing beers.

We think that the unexpected result of Hypothesis 2 is due to an organization's *deliberate* decision to compromise between product scope additions and style diversification. As the nature of our dataset allows us to discriminate between these two product scope dimensions and as we are thus able to observe if organizations trade off new product launches and dispersion of beer styles, we believe that our initial reasoning behind Hypothesis 2 still holds. As population density increases, organizations *could* potentially still take advantage of the increased amount of resources available in the market to span industrial processes. However, our finding implies that organizations decide not to launch new products into too many styles categories in a simultaneous way, but that they focus on a few of them and increase product launches in the selected within-niche market accordingly (Barroso & Giarratana, 2013). This strategy could be explained by the following three reasons.

To begin with, organizations are faced with various cost constraints. Previous studies find that implementing new products, methods, and routines is costly as it requires resources in terms of advertisement, time, and internal coordination (Barnett, 1997; Nelson & Winter, 1982). As a result, organizations that introduce products incrementally are more likely to survive than organizations that launch a large number of products simultaneously (Barnett & Freeman, 2001). Furthermore,

changes in organizational procedures require a lot of coordination and flexibility across organizations, which, if exaggerated, may negatively affect the quality of already existing products (Rahmandad & Repenning, 2016). For these reasons, simultaneous across-niche and within-niche product diversifications are too costly to sustain. Hence, firms select those style categories where they consider themselves as most competitive and leverage and enhance their established core competencies accordingly (Abernathy & Clark, 1985).

Furthermore, organizations strive to avoid learning myopia and thus balance between exploration and exploitation (March, 1991). Solely investing in the exploration of new industrial processes certainly positively increases the likelihood of coming up with new ideas that eventually lead to potential innovations. However, research and development activities might not just be time-consuming but also hazardous for organizations to conduct, as they lack sufficient experience to predict the market reaction towards their new innovation and thus may fail to successfully recover their occurred expenditures. On the contrary, introducing new products in every single style category may, as previously explained, not be feasible under a financial point of view. Differently, our results demonstrate that an increased number of new product launches gets progressively distributed over a narrower range of beer styles as population density rises. This means, that even though exploring new market opportunities still matters for remaining competitive and innovative in the market, real ale breweries decide to specialize their competencies in a small range of beer styles to efficiently cope with the aforementioned organizational constraints. Therefore, consistent with the literature (March, 1991), we observe that firms strive for a balanced portfolio mix with a lot of launches within a few style categories as population density increases.

Lastly, having several products within the same sub-market, i.e. styles, deters competitors from entering the market (Bayus & Putsis, 1999). In fact, a wide product variety offered by incumbent firms entails higher entry barriers for potential rivals to overcome as their investment costs for entering the market would increase significantly (Caves & Porter, 1977; Requena-Silvente & Walker, 2009; Stavins, 1995). However, by limiting the variety of products to a few sub-markets, yet keeping the number of launched products high, firms not only specialize in the given target field but concurrently deter rivals from entering it.

Altogether, in this study we tried to understand how a change in population density affects a beer manufacturer's product scope strategy. We find that when population density is low and thus geographical distance among real ale breweries is high, diversification of product scope through launches of new products is medium and distributed across a relatively high number of different

beer styles. In other words, a low population density is characterized by a low number of closeby rivals, which minimizes the likelihood that these rivals compete for the same market segment and thus generates weak pressures for removing firms from the market (Hannan & Freeman, 1977). For these reasons, firms have less incentive to specialize but choose to instead introduce a variety of different products. On the contrary, we find that when population density is high, the likelihood of overlapping with competitors increases. By narrowing down the range of product styles but increasing the number of new product launches *within* these, firms decrease the likelihood that competitors enter their market segments by increasing cost efficiency; by balancing the level of exploitation around new style categories, while still exploring new segments through new product launches; and by increasing entry barriers that maintain high product variety. Our findings are therefore consistent with previous papers of the field (Barroso & Giarratana, 2013; Carroll, 1985).

Second, our study highlights the importance of considering the density-dependent behavior of organizations that remain active in the market while others enter or leave the competitive field. In fact, although scholars have widely recognized the impacts of population density on organizational founding and mortality (Hannan & Freeman, 1977, 1989), limited attention has been paid to how alive actors change their strategic endeavor upon altering firm density. By enhancing this perspective beyond organizational birth and death and connecting it to prior studies on product scope proliferation strategies, we show that population density should explicitly be taken into account when analyzing incumbent firms' product line adjustments. Specifically, we prove our arguments in a mature industry that is characterized by a large number of organizational players with various heterogeneous products. Within this well-developed business environment, competition is more prevalent than legitimacy. This is because firms are already well established in this market phase, which shifts organizational emphasis away from identity diversification to organizational survival and market dominance (Hannan & Carroll, 1992).

When population density is high and market participants, on average, increase their product line length, each product becomes less valuable (Sorenson, 2000) and thus organizations need to compete by other mechanisms, such as price or location (Beck, Swaminathan, Wade, & Wezel, 2018; Quelch & Kenny, 1994). In contrast, when population density is low, identity matters significantly (Hannan & Freeman, 1977). Against the background of our findings within a mature industry, we argue therefore that product scope decisions in *emerging* industries are characterized by a



moderately high number of product introductions with a low style differentiation. The underlying reasons for our assertion are twofold.

To begin with, an emerging industry typically consists of just a few companies that center their business activities around a new idea, product, or technology. Due to this novelty and the market's early stage of development, legitimacy exerts a preponderant force on participating organizations (Hannan & Freeman, 1977). As mentioned at the beginning of this paper, legitimacy is commonly referred to as the social justification of an actor, such that the actor is publicly validated or endorsed (Perrow, 1961). In particular, the process of social validation involves the recognition of a distinctive competency possessed or role-played by an organization in providing a good or service and is eventually essential for its survival (Dowling & Pfeffer, 1975). Consequently, firms participating in a developing market strive to be legitimized. Moreover, it needs to be emphasized that this legitimacy and ultimately customer loyalty are not attainable under an initially broad and dispersed product scope for the following reasons. First, having an excessive variety of products requires high costs for production and eventual introduction of these products onto the market. Second, customers will hardly identify an organization's strength when faced with a wide product range. As incumbent organizations have the advantage of holding good market positions, entering the market with a broad variety of products not only makes it difficult to coordinate market moves when responding to rivals, but also decreases the likelihood of offering more attractive products than these more experienced rivals.

Beyond that, new ventures are typically equipped with limited monetary, human, and temporal resources – both at an absolute level and also relative to mature firms. By virtue of these constraints and the necessity to establish organizational identity, we contend that firms will introduce just a few products that are fairly concentrated within a few style categories onto the developing market. As the market grows, these firms gain more experience in the market, thereby understand their most successful products and their styles and accordingly safeguard them by strengthening their core competencies within these respective style categories. In line with the reasoning given for mature firms we assume therefore, that firms in an emerging market will after a while expand their operations by new product launches within their selected specialization.

We anticipate that our study can be safely replicated in other countries with sectors that share similar attributes to the British real ale brewing industry. Owing to the observed systematic effect competition exerts on product scope expansion decisions in mature industries, we claim that an appropriately fluctuating, heterogeneous, and large number of alive actors with altering product

scopes is a sufficient prerequisite for obtaining comparable results elsewhere. We plead, however, to consider country-specific variables that potentially affect firm entrance or production volume. For instance, small breweries in the United Kingdom have been since the year 2002 protected by the so-called *Progressive Beer Duty*, which has led to a lower tax burden for small enterprises and thereby has nurtured investments and product variety (Society of Independent Brewers, 2012). As soon as these domestic factors are explicitly accounted for, we are confident that the relationships found in our study are to a large extent generalizable across different domestic and industrial contexts.

## 6.2. Implications for Managers

In line with these two contributions to literature, we emphasize the managerial relevance of our findings. Foremost, our findings imply that a widening of product scope without a simultaneous widening of product variety constitutes a cost-efficient technique of strategic behavior for firms operating in a competitive business environment. As indicated earlier, we find support that organizations act ambidextrously by balancing exploration and exploitation, which has been widely claimed as critical for survival in the present as well as for sustainable growth in the future (Cao et al., 2009; He & Wong, 2004; Tushman & O'Reilly, 1996). However, managing this duality creates paradoxical challenges since the underlying processes and structures of these two activities often contradict each other (Smith & Tushman, 2005). Our study provides insights for that mature organizations are able to maintain dual attention on both exploration and exploitation – with the respective level of each activity being contingent on the prevalent firm density and thereby competitive intensity. More precisely, these firms tend to engage in exploitation by *refining* their existing product line's style when population density is high.<sup>14</sup> Simultaneously, they explore new market segments by launching additional products into these same style categories. In doing so, these organizations *appear* to their customers as being more diversified, while they *actually* concentrate their product varieties within a few of their core competencies and thus operate effectively with their given resource constraints. Intuitively, this combination sounds like a

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<sup>14</sup> The following elaborations on exploration and exploitation are based on the assumption that an increase in the style dispersion of a company's product line leads to more launched styles in addition to the ones already applied. In contrast, we assume that an unchanged level of style dispersion means that a firm continues to launch within the same style categories.

contradiction. However, our empirical analysis shows that British real ale breweries follow a dual strategy in response to competition and that these dimension-specific approaches are able to exist next to and complement each other.

In turn, a lower population density induces organizations to focus on characteristic exploration activities, such as search and experimentation (March, 1991) which entail the discovery of new product styles that might subsequently get incorporated into the current product line. In accordance with the reasons on a company's given resource constraints given earlier, we assert that the style dispersion increases under a lower population density and thus under less competition, as the time for experimenting with new product variants increases, the pressure to quickly introduce new products due to launch strategies by rivaling firms decreases, and more possibilities or willingness for across-firm collaboration open up. Consequently, under less competition managers should make use of these opportunities and allow sufficient time for exploration activities outside the boundaries of their current product varieties to sustain in the long-run. This two-sided approach enables them to achieve efficiency in the short term to address their survival needs in the present and also continuously innovate to focus on their sustainable growth needs in the future (Tushman & O'Reilly, 1996). As such, our study demonstrates that balancing these conflicting demands for organizational resources is manageable and an often conducted practice in organizations.

## **7. Conclusion**

In response to the lack of academic research that examines the impact of population density on product scope expansions, we proposed two assumptions concerning the relationship between these two focal topics in a mature market. Borrowing arguments from different streams of literature that address the linkage between competition and innovation, we argued that population density positively affects the number and style diversification of a firm's newly introduced products onto the market. A sample of 2,010 British real ale breweries and their respective beer launches over the period 2000 to 2018 was used to test these two hypotheses under a quantitative research approach. As such, we examined the two dimensions of product scope – product breadth and product depth – separately in order to accurately assess and unravel the effect of population density on either of them.

The evidence from our study shows that these two integral components of an organization's product scope behave differently upon changing population density: On the one hand, population

density induces organizations to launch new products. On the other hand, however, these additional products are less likely characterized by a wide style variety.

Our results contribute to the existing literature on density-dependence and product scope in several ways. First, our statistical analysis suggests that population ecology scholars should start acknowledging the hitherto not considered effect of firm density on product scope and thereby expand the theory's current perspective beyond organizational birth and death. Second, we reconcile the two philosophies on innovation and competition and demonstrate that firms in a mature market combine those in their product launch strategies through a high product breadth, yet a rather concentrated product depth. This finding should not be underestimated. Given the changing number of competitors and thus population density in the British real ale brewing industry, decisions on product scope proliferation are in fact driven by external factors and do surprisingly not contradict but veritably complement each other. Lastly, our findings bear important managerial relevance. Specifically, organizations are best advised to act ambidextrously by exploring new market segments through additional product introductions while simultaneously exploiting existing core competencies within a few product style categories. Doing so offers a cost-efficient way to react upon high competition in a mature business environment.

## 8. Limitations

Despite the earlier described contributions of our research to academia and managerial practice, several important limitations need to be acknowledged.

One of the biggest shortcomings of our study at the *firm level* is that we cannot capture the effect of a brewery's relocation since this information is generally neither provided in *The Directory of UK Real Ale Brewers* nor on *RateBeer*. Although we did incorporate the few relocations we were exceptionally made aware of, it needs to be emphasized that our hypothesis tests were most likely not conducted on an entirely up-to-date database. In the same vein, we cannot observe if a brewery changed its name and additionally moved to another premise during the inspected 19 years. Within the scope of our possibilities, however, we sought to mitigate the drawback of double counts by verifying and aligning data entries with identical ZIP codes with information about name changes provided in either one of the two aforementioned data sources. This manual approach enabled us to at least isolate any renaming events of breweries that did not change their geographical location. Yet, as a – rather unlikely, but still possible – simultaneous shift in both name and location cannot

be systematically detected, we do not claim that our 2,010 investigated real ale breweries are mutually exclusive.

Furthermore, while ratings themselves were not of particular interest for our study, it needs to be highlighted that our obtained information at the *product level* was merely accessible on *RateBeer* once individual users began reviewing a brewery's beer. By default, our extracted product listings consequently show in essence only those beers that were interesting to consume and review. We also believe that our product data are somewhat skewed towards more recent years as the rapid expansion of the internet and likewise the availability of smartphones and *RateBeer's* own rating app (RateBeer, 2017) ought to have massively contributed to beer enthusiasts' willingness to enter, update, and review their consumed beers online and by that to the easier and more frequent provision of product-specific data for our study purpose. Equally, breweries that launched beers prior to the go-life date of *RateBeer* in the year 2000 might have been coded with product introductions in this year or even beyond, contingent on when the first rating of these beers happened. Correspondingly, especially beers that were brought to the market towards the end of the year 2018 might not be part of our data extract either, as the time interval between launch and cut-off date for our data collection on January 20<sup>th</sup>, 2019 might have been too short for ratings to take place.

Moreover, as beer raters are obliged to select a beer's style among a variety of different subcategories on their own and as this aspect is not captured in the otherwise quite rigorous quality assurance controls that *RateBeer* have established (RateBeer, 2019c), we cannot guarantee that the provided style classifications for all 63,146 beers truly correspond to reality, thus leading to some potential flaws in the calculation of the product lines' style dispersion. In absence of other, yet unbiased, publicly available product data of British real ale breweries, we were unfortunately neither able to triangulate our data nor implement an objective measure of a beer manufacturer's product line.

Nonetheless, as our database is with more than 2,000 breweries, 60,000 beers, and 800,000 individual user ratings relatively big and as our chosen observation period of 19 years is long enough, we are confident that our data aided in answering our stated hypotheses and eventually enhanced our understanding of an organization's product scope strategy under a density-dependence perspective.

## 9. Recommendations for Future Studies

Considering that our study could be securely extended towards industries with similar changes in market participants and product lines, future studies might attempt to analyze the pursued product scope strategies of incumbent firms not only at the firm- but also at the product level. In accordance with prior research focusing on the benefits and downsides of being the first organization to launch a particular type of product (Khanna, 1995; Lieberman & Montgomery, 1988; Mitchell, 1989), we propose to investigate if a higher population density prompts incumbent firms to *match* their offered product variants to those of their competitors or if they commence launching *explicitly different* ones. In doing so, incorporating data on material or production costs as well as sales volume could aid in a more rigorous examination of the relationship between product scope expansion and population density on the product level. Likewise, and following the argumentations of international business scholars on the choice of product line and the characteristics of organizational decision-making within multinational enterprises (Bowman, Duncan, & Weir, 2000; Doz & Prahalad, 1981; Thomas, 2011), it would be interesting to inspect how local population density affects the overall product scope decisions of globally operating firms. Both fine-grained analyses would serve as a much-needed complement to our research by shedding light on how organizations exactly behave upon changing firm density at a detailed product level.

Additionally, we see potential for other scholars to empirically explore the density-dependent product scope proliferation strategies of firms with different organizational characteristics. It has, for instance, already been confirmed (Barnett, 1997) that firm size influences the way organizations compete. Similarly, firm age tends to negatively impact an organization's level of innovation (Hansen, 1992). Explicitly accounting for these and other aspects of firm heterogeneity and subsequently examining their impact on product scope decisions in mature industries would, in our opinion, offer a fruitful route for future research.

Lastly, replicating our study in an emerging market context by incorporating a measure for legitimacy would open up another exciting avenue for further research and complement our findings on the competitive dimension of population density in mature industries. In doing so, our thoughts outlined in the discussion part could be empirically proven and validated.

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## **11. Appendices**



*Appendix 1 – Regression Results for Product Scope Breadth (Hypothesis 1) with Fixed-Effects Negative Binomial Regression*

VARIABLES	Number of Launches (Lead)		
	Model 7	Model 8	Model 9
Distance (ln) <sup>2</sup> <sup>α</sup>			242.543*** (39.240)
Distance (ln) <sup>α</sup>		-409.898*** (108.750)	-9,764.112*** (1,521.572)
Cumulative Number of Beers <sup>α</sup>	2.269*** (0.308)	2.288*** (0.311)	2.357*** (0.306)
Herfindahl-Hirschman Index	27.046*** (5.384)	-11.617 (11.607)	-24.736** (12.223)
Market Size <sup>α</sup>	0.001 (0.012)	-0.004 (0.012)	-0.004 (0.012)
Relative Firm Size <sup>α</sup>	391.012*** (119.155)	365.614*** (119.085)	377.001*** (118.628)
Firm Age <sup>α</sup>	-0.859 (0.656)	-0.777 (0.653)	-0.608 (0.663)
Constant <sup>α</sup>	749.358*** (54.188)	8,932.369*** (2,173.100)	99,085.670*** (14,835.290)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	12,047	12,047	12,047
Number of Real Ale Breweries	1,589	1,589	1,589

Standard Errors in Parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

## Appendix 2 – Regression Results for Product Scope Depth (Hypothesis 2) with Fixed-Effects Panel Regression

VARIABLES	Style Dispersion of Launches (Lead)		
	Model 10	Model 11	Model 12
Distance (ln) <sup>2</sup> <sup>α</sup>			37.147*** (11.753)
Distance (ln) <sup>α</sup>		469.418 (302.238)	-1,006.190* (556.048)
Number of Launches <sup>α</sup>	4.238*** (0.507)	4.222*** (0.507)	4.092*** (0.508)
Style Dispersion of Cumulated Beers <sup>α</sup>	-258.430*** (20.732)	-259.819*** (20.749)	-264.856*** (20.798)
Herfindahl-Hirschman Index	-18.996** (9.091)	17.674 (25.300)	12.087 (25.347)
Market Size <sup>α</sup>	0.096*** (0.034)	0.098*** (0.034)	0.106*** (0.034)
Relative Firm Size <sup>α</sup>	-22.596 (42.795)	-19.778 (42.830)	-6.970 (42.996)
Firm Age <sup>α</sup>	-13.323 (9.237)	-20.843** (10.428)	-20.514** (10.423)
Constant <sup>α</sup>	538.976** (232.282)	-8,630.820 (5,908.606)	6,016.052 (7,506.279)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	9,445	9,445	9,445
Number of Real Ale Breweries	1,744	1,744	1,744

Standard Errors in Parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

*Appendix 3 – Regression Results for Product Scope Breadth (Hypothesis 1) with Random-Effects Negative Binomial Regression excl. Relative Firm Size*

VARIABLES	Number of Launches (Lead)		
	Model 13	Model 14	Model 15
Distance (ln) <sup>2</sup> <sup>α</sup>			253.339*** (37.522)
Distance (ln) <sup>α</sup>		-239.390*** (75.575)	-10,093.560*** (1,464.135)
Cumulative Number of Beers <sup>α</sup>	3.094*** (0.204)	3.087*** (0.206)	3.147*** (0.202)
Herfindahl-Hirschman Index	28.881*** (5.074)	6.099 (8.815)	-15.660 (9.607)
Market Size <sup>α</sup>	0.063*** (0.009)	0.060*** (0.009)	0.060*** (0.009)
Firm Age <sup>α</sup>	-0.294 (0.527)	-0.266 (0.526)	-0.141 (0.529)
Constant <sup>α</sup>	694.740*** (48.099)	5,473.751*** (1,510.016)	101,310.500*** (14,327.210)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	12,598	12,598	12,598
Number of Real Ale Breweries	1,908	1,908	1,908

Standard Errors in Parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

## Appendix 4 – Regression Results for Product Scope Depth (Hypothesis 2) with Random-Effects Panel Regression excl. Relative Firm Size

VARIABLES	Style Dispersion of Launches (Lead)		
	Model 16	Model 17	Model 18
Distance (ln) <sup>2</sup> <sup>α</sup>			27.476*** (9.930)
Distance (ln) <sup>α</sup>		71.094*** (12.838)	-999.697*** (387.137)
Number of Launches <sup>α</sup>	5.667*** (0.355)	5.757*** (0.354)	5.736*** (0.354)
Style Dispersion of Cumulated Beers <sup>α</sup>	161.742*** (14.461)	152.515*** (14.549)	151.893*** (14.543)
Herfindahl-Hirschman Index	-3.361 (1.476)	3.238* (1.895)	0.881 (2.075)
Market Size <sup>α</sup>	0.017*** (0.002)	0.018*** (0.002)	0.018*** (0.002)
Firm Age <sup>α</sup>	-0.237 (0.091)	-0.253*** (0.090)	-0.245*** (0.090)
Constant <sup>α</sup>	153.945*** (10.138)	-1,262.933*** (255.983)	9,171.213** (3,778.572)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	9,445	9,445	9,445
Number of Real Ale Breweries	1,744	1,744	1,744

Standard Errors in Parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

## Appendix 5 – Regression Results for Product Scope Breadth (Hypothesis 1) with Zero-Inflated Negative Binomial Regression

VARIABLES	Number of Launches (Lead)		
	Model 19	Model 20	Model 21
Distance (ln) <sup>2</sup> <sup>α</sup>			241.721*** (42.360)
Distance (ln) <sup>α</sup>		-21.246 (39.195)	-9,425.517*** (1,647.673)
Cumulative Number of Beers <sup>α</sup>	8.798*** (0.640)	8.795*** (0.640)	8.887*** (0.638)
Herfindahl-Hirschman Index	9.829 (7.892)	7.860 (8.686)	-10.019 (9.167)
Market Size <sup>α</sup>	0.124*** (0.006)	0.123*** (0.006)	0.124*** (0.006)
Relative Firm Size <sup>α</sup>	3,022.441*** (183.885)	3,019.362*** (183.971)	2,977.050*** (183.596)
Firm Age <sup>α</sup>	-3.381*** (0.250)	-3.371*** (0.251)	-3.304*** (0.251)
Constant <sup>α</sup>	751.885*** (43.124)	1,176.819 (785.134)	92,644.090*** (16,032.010)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	12,598	12,598	12,598
Number of Non-Zero Observations	9,445	9,445	9,445
Number of Zero Observations	3,153	3,153	3,153

Standard Errors in Parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

## Appendix 6 – Regression Results for Product Scope Depth (Hypothesis 2) with Random-Effects Panel Regression and Number of Different Styles per Launch

VARIABLES	Number of Different Styles per Launch (Lead)		
	Model 22	Model 23	Model 24
Distance (ln) <sup>2</sup> <sup>α</sup>			128.805*** (41.433)
Distance (ln) <sup>α</sup>		300.748*** (59.267)	-4,721.461*** (1,616.588)
Number of Launches <sup>α</sup>	56.018*** (1.759)	56.099*** (1.756)	55.846*** (1.757)
Style Dispersion of Cumulated Beers <sup>α</sup>	706.766*** (61.806)	672.231*** (62.151)	663.522*** (62.185)
Herfindahl-Hirschman Index	-5.768 (6.037)	21.961*** (8.132)	10.473 (8.930)
Market Size <sup>α</sup>	0.089*** (0.007)	0.095*** (0.007)	0.096*** (0.007)
Relative Firm Size <sup>α</sup>	-491.000*** (134.846)	-449.425*** (134.769)	-430.395*** (134.853)
Firm Age <sup>α</sup>	-0.405 (0.447)	-0.505 (0.445)	-0.487 (0.445)
Constant <sup>α</sup>	1,377.750*** (42.533)	-4,617.074*** (1,181.805)	44,348.430*** (15,795.140)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	9,445	9,445	9,445
Number of Real Ale Breweries	1,744	1,744	1,744

Standard Errors in Parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

## Appendix 7 – Regression Results for Product Scope Depth (Hypothesis 2) with Random-Effects Panel Regression and Number of Different Styles per Launch &gt; 1

VARIABLES	Number of Different Styles per Launch > 1 (Lead)		
	Model 25	Model 26	Model 27
Distance (ln) <sup>2</sup> <sup>α</sup>			24.111 (59.216)
Distance (ln) <sup>α</sup>		235.243*** (56.954)	-706.472 (2,314.448)
Number of Launches <sup>α</sup>	47.414*** (1.806)	47.574*** (1.800)	47.524*** (1.801)
Style Dispersion of Cumulated Beers <sup>α</sup>	1,278.179*** (73.681)	1,223.287*** (74.892)	1,220.035*** (74.974)
Herfindahl-Hirschman Index	1.863 (10.409)	21.713* (11.455)	19.764 (12.444)
Market Size <sup>α</sup>	0.039*** (0.006)	0.043*** (0.006)	0.043*** (0.006)
Relative Firm Size <sup>α</sup>	-745.921*** (137.249)	-701.256*** (136.951)	-700.694*** (137.174)
Firm Age <sup>α</sup>	0.315 (0.377)	0.176 (0.375)	-0.184 (0.377)
Constant <sup>α</sup>	1,999.415*** (57.812)	-2,676.560** (1,133.039)	6,520.886 (22,633.520)
Year of Product Launch Dummies	Yes	Yes	Yes
Number of Observations	4,413	4,413	4,413
Number of Real Ale Breweries	1,310	1,310	1,310

Standard Errors in Parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

<sup>α</sup> Coefficients and Standard Errors Multiplied by 1,000

