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ENTRY AND INNOVATION. AN EMPIRICAL ANALYSIS OF THE ELECTRONIC CIGARETTES INDUSTRY

ENTRATA E INNOVAZIONE. UN'ANALISI EMPIRICA DEL SETTORE DELLE SIGARETTE ELETTRONICHE

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ABSTRACT

This thesis explores the dynamic electronic cigarette industry, focusing on how technological innovation drives market entry and exit, contributing to the sector's rapid evolution. Since the first commercial e-cigarette was launched in 2003, the industry has grown significantly, pushed by consumer interest in alternatives to traditional smoking. The study offers an empirical analysis, segmenting the industry into six distinct markets and examining the influence of various factors – such as company experience in the tobacco sector, firm size, and e-liquid production expertise – on market entry.

Through quantitative analysis of a comprehensive dataset, this research identifies key patterns shaping firm behaviour and competition within the industry. It addresses significant regulatory challenges, noting how global policies impact innovation and the balance between harm reduction for adult smokers and youth prevention. Assumptions were made regarding data limitations, particularly around exit years for first-generation products, with 2018 used as a benchmark for undetermined dates, acknowledging this as a pivotal year for industry transitions.

This thesis contributes to the broader literature on technology-driven market evolution, providing insights into the e-cigarette industry's structure, the role of submarkets, and the impact of external regulatory pressures. The findings highlight the complex reciprocity of market forces and innovation in an industry still shaping its trajectory.

ABSTRACT

Questa tesi esplora la dinamica dell'industria delle sigarette elettroniche, concentrandosi su come l'innovazione tecnologica influenzi l'ingresso e l'uscita dal mercato, contribuendo alla rapida evoluzione del settore. Dalla commercializzazione della prima sigaretta elettronica nel 2003, l'industria ha registrato una crescita significativa, stimolata dall'interesse dei consumatori per alternative al fumo tradizionale. Lo studio offre un'analisi empirica, segmentando l'industria in sei distinti mercati ed esaminando l'influenza di vari fattori, come l'esperienza delle aziende nel settore del tabacco, la dimensione aziendale e la competenza nella produzione di e-liquid, sull'ingresso nel mercato.

Attraverso un'analisi quantitativa di un ampio dataset, questa ricerca identifica i principali modelli che plasmano il comportamento delle aziende e la concorrenza all'interno del settore. Si affrontano anche le sfide normative significative, evidenziando come le politiche globali influenzino l'innovazione e l'equilibrio tra la riduzione del danno per i fumatori adulti e la prevenzione tra i giovani. Sono state fatte alcune ipotesi riguardo alle limitazioni dei dati, in particolare sugli anni di uscita dei prodotti di prima generazione, utilizzando il 2018 come punto di riferimento per le date non determinate, riconoscendolo come un anno cruciale per le transizioni nell'industria.

Questa tesi contribuisce al più ampio dibattito sull'evoluzione del mercato guidata dalla tecnologia, fornendo approfondimenti sulla struttura dell'industria delle sigarette elettroniche, sul ruolo dei sottosettori e sull'impatto delle pressioni normative esterne. I risultati evidenziano la complessa interazione tra le forze di mercato e l'innovazione in un settore che sta ancora definendo la propria traiettoria.

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CHAPTER 1: INTRODUCTION

The electronic cigarette industry has experienced rapid and significant growth over the past two decades, driven by technological innovation and shifts in consumer preferences toward alternatives to traditional smoking. Since the release of the first commercial model in 2003, the industry has diversified with the introduction of new generations of devices, evolving from simple *cigalike* models to advanced devices such as box mods and pod mods.

The first commercialized electronic cigarette was design to resemble classic cigarettes and was not rechargeable, while in the second-generation devices started to lose the resemblance with cigarettes (hence called *vape pens*) and evolved to be rechargeable, with the introduction of various flavours of e-liquids. In the third generation, electronic cigarettes became even more customizable, featuring adjustable vapour intensity settings, larger tanks, and increasingly diverse designs. The fourth generation replaced e-liquids with disposable pods, returning to a simpler design and paving the way for modern disposable e-cigarettes that no longer rely on refillable e-liquids. This technological evolution has supported a growing market, driven by increasing demand for products that provide customizable experiences and are perceived as having a lower health impact than traditional smoking.

The industry has also been profoundly influenced by a constantly evolving regulatory landscape aimed at controlling the production and distribution of electronic cigarettes. Global regulations seek to balance the harm reduction benefits for adult smokers with concerns around youth usage and environmental impacts, particularly with the rise of disposable e-cigarettes.

This thesis aims to provide an empirical analysis of the electronic cigarette industry, with a specific focus on how innovation shapes market entry and exit, and more in general industry evolution, adding to the extensive literature on technology and industry evolution. Using a comprehensive dataset and quantitative analysis methods, by dividing the industry into six different markets, the study seeks to identify the key dynamics that drive the entry of new firms within a rapidly transforming sector.

The aim of this thesis is to assess whether factors like previous experience in the tobacco industry or in other generations, size, or experience in the production of e-liquids influence entry in each market.

To conduct this study, several assumptions were made. When the exact exit year for first-generation products could not be determined, 2018 was assumed, as this year marked a period of significant industry activity, with numerous companies exiting and the modern disposable e-cigarette emerging. Initially, the variable CompanyAgeatEntry was considered a proxy for company size, but within this dataset, it appears not to reliably reflect a company's size. Additionally, obtaining information on exit years, or about companies no longer active, proved to be challenging. For this reason, the dataset comprises few companies active in the first generation, compared to companies active in following generation, and this might have affected the results.

The next chapter will provide a review of existing literature on industry evolution and the role of submarkets in shaping this evolution. The following chapters will offer a detailed overview of the industry, illustrate the industry evolution, present the findings from the empirical research, and discuss the related results.

Chapter 2: Review of the Literature

This chapter provides an overview of key theoretical frameworks and empirical research on industry evolution, examining the dynamics of technological change and entry and exit patterns. It explores established models that describe the lifecycle of industries, highlighting the role of innovation. By synthesizing perspectives from technology management, evolutionary economics, and organizational ecology, this chapter underscores the multifaceted nature of industry evolution, offering insights into how firms navigate and shape their competitive landscapes over time.

2.1. Technology and Industry Evolution

Following the initial commercialization of a product, industries typically undergo a progression marked by notable regularities in the trends of key variables, including the number of firms, sales, prices, and patterns of innovation (Agarwal and Tripsas, 2008).
For exposition purposes, we present three stages of industry evolution – emergence/growth, shakeout, and maturity – which form the core model presented in the literature. In the initial stage, high levels of uncertainty pervade every aspect of the industry. Firms test a range of technologies, as the performance paths of various options remain unclear. Customers have undeveloped preferences and explore different product applications. During this period, the market is small, production methods are not specialized, and manufacturing processes are inefficient. While some industries may not progress beyond this stage, those that do typically experience rapid growth as the new technology spreads among consumers. This stage is marked by the entry of diverse firms, including entrepreneurial startups and businesses diversifying from related sectors. Moreover, high levels of product innovation define this

phase, although the emphasis on process innovation grows over time (Agarwal and Tripsas, 2008).

The transition to the shakeout stage occurs as production efficiencies are achieved and product designs become standardized, resulting in a dominant model. On the demand side, as consumers become more used to industry products, their preferences stabilize, leading to reduced product variety. This stage is therefore marked by a growing focus on process innovation over product innovation, with large, established firms increasingly driving innovations. Competitive pressures intensify due to economies of scale and specialized manufacturing processes, which heighten efficiency and lead to a swift reduction in the number of firms. Toward the end of this phase, the growth rates of sales and price changes begin to slow down, even if production generally increases, and prices continue to fall, especially when adjusted for quality improvements (Agarwal and Tripsas, 2008).

In the mature phase, industry growth slows, and both technological and competitive conditions stabilise. This phase is characterised by a stable number of firms, with entry and exit occurring at positively correlated but lower rates than in previous stages. While some product and process innovation persist, most advancements are incremental. The industry at this stage tends to see stable pricing, steady sales growth, and an established infrastructure supporting its operations (Agarwal and Tripsas, 2008).

Ultimately, industries in this stable period may either enter a decline phase or cycle back into an emergent state if disrupted by significant technological innovations. This cycle of emergence, shakeout, and maturity can repeat multiple times as waves of disruptive technological change reshape the industry over time (Agarwal and Tripsas, 2008).

This stylized description is supported by extensive empirical research documenting a wide array of consistent patterns (Agarwal and Tripsas, 2008).

2.2. Empirical Regularities

Patterns of Technological and Industry Evolution

The technology life cycle literature is based on the idea that evolutionary changes in technology drive the development of many new industries. Recognizing patterns of technological change over time is thus essential to understanding competitive dynamics (Agarwal and Tripsas, 2008). The empirical regularities emerged from these studies are listed below.

Innovative activity: In the early stages of most industries, technical diversity is high, with a variety of innovations embodied in a range of competing products. These early products differ in appearance, use different technologies, emphasize various functions, and offer unique features. (Agarwal and Tripsas, 2008) This phenomenon is widely documented. For instance, in the early automotive industry, steam and electric engines coexisted alongside what would become the dominant internal combustion engine, and some cars were built with three wheels instead of four (Abernathy, 1978; Basalla, 1988).

Two key studies have directly measured technical diversity across various stages of the technology life cycle. Anderson and Tushman (1990) investigated technological change in the Portland cement, minicomputer, and glass-manufacturing industries, identifying phases marked by technological breakthroughs (discontinuities), intense innovation (ferment), the establishment of dominant designs, and phases of incremental evolution. They compared the number of new designs introduced during periods of ferment with those in incremental phases and discovered that in three out of four cases, significantly more designs emerged during ferment periods. Similarly, in their longitudinal study on the development of cochlear implants, Van de Ven and Garud (1993) created a chronological record of 771 significant events from 1955 to 1989, organizing these events into three major categories: variation

events (that generated technical innovation), selection events (that changed institutional rules), retention event (that followed existing rules) (Van de Ven and Garud, 1993).
Research has also highlighted the relative importance of product innovation compared to process innovation throughout the stages of the industry life cycle. Utterback and Abernathy (1975) analysed the nature of innovation across different industry stages using Myers and Marquis's (1969) dataset, which included 567 innovations from 120 firms across five industries. They classified each firm into one of three stages, and observed that product innovation was initially high but declined over time, while process innovation started low and then increased. Abernathy (1978) observed a similar trend in his detailed study of the automobile industry.

Emergence of a dominant design. A key turning point in many industries is the emergence of a dominant design – a widely accepted product architecture featuring standardized modules and interfaces with a specific set of features (Agarwal and Tripsas, 2008). This design aligns technological choices with user preferences, effectively guiding further developments in both design and consumer needs (Clark, 1985). Research has identified dominant designs across various industries, including: automobiles, transistors, typewriters, TV picture tubes, televisions, and electronic calculators (Utterback and Suarez, 1993; Suarez and Utterback, 1995). Anderson and Tushman (1990) defined the emergence of a dominant design as the point at which a specific technology captures more than 50% of the market.
After a dominant design emerges, firms tend to concentrate on refining it. Periods of incremental technological change following dominant designs have been observed in industries such as cement, minicomputers, glass (Anderson and Tushman, 1990), synthetic dyes (Murmann, 2003), and machine tools (Noble, 1984). Stuart and Podolny (1996) analysed patent data from the semiconductor industry (1978–1992) to assess technological focus and

found that firms generally remained within their established technological niches, with minimal shifts over time.

Incremental improvements following the emergence of a dominant design can lead to substantial advancements. For instance, in the typesetter industry, incremental innovations in the hot metal line caster architecture increased speed a hundred times over 50 years (Tripsas, 2008). Significant innovation also occurs within modular subsystems, as seen in the mainframe computer, personal computer, and automobile industries, where improvements to subsystems have considerably boosted performance (Abernathy and Clark, 1985; Baldwin and Clark, 2000; Iansiti and Khanna, 1995; Bayus and Agarwal, 2007).

Subsequent technological discontinuities. The technology management literature extensively examines technological discontinuities that disrupt the mature stage of industries, creating new cycles of turbulence similar to the early industry stages (Agarwal and Tripsas, 2008). Multiple cycles of discontinuous and incremental change have been documented. In the photography industry, for example, collodion plates, gelatin plates, and roll film each sparked significant ferment (Jenkins, 1975). Technological disruptions have also been recorded in various established industries, such as diesel locomotives replacing steam engines, and jet engines replacing propellers (Cooper and Schendel, 1976). Such disruptions often lead to increased new entries into industries previously stable, as observed, in photolithography (Henderson, 1993), for instance.

Number of firms, entry, and exit. While the technology life cycle literature defines stages by technological shifts, many studies show a clear link between these shifts and changes in firm numbers. Generally, industries see high initial entry with minimal exit, followed by a shakeout phase characterized by high exit rates and fewer new entries, forming an inverted U-shaped trend in firm numbers over time (Agarwal and Tripsas, 2008). This pattern has been observed in several industries, including automobiles, transistors, typewriters, and TVs, with the shakeout often aligning with the emergence of a dominant design (Utterback and Suarez, 1993).

Firm Performance

Empirical research in technology management often explores the competitive impacts of technological disruptions, examining which firms introduce new technologies, what aspects drive technological success, and which firms are more likely to survive (Agarwal and Tripsas, 2008).

Research shows that new entrants often introduce radically new technologies. Cooper and Schendel (1976) found that in four out of seven industries studied, major technological innovations came from outside the existing industry. Tushman and Anderson (1986) further demonstrated that innovations enhancing incumbent competencies tend to come from established firms, while disruptive, competence-destroying innovations typically originate from new entrants. Sometimes, a technological breakthrough in one industry is actually the application of gradually evolving technology from another field. For example, Levinthal (1998) showed how wireless communication progressively transformed various new applications over time.

Studies comparing incumbents and new entrants suggests that new entrants often outperform incumbents, especially when facing competence-destroying, architectural, disruptive, or complementary asset-reducing technologies (Tushman and Anderson, 1986; Henderson and Clark, 1990; Christensen and Bower, 1996; Tripsas, 1997b). Studies on entry timing relative to a dominant design indicate that firms entering before the establishment of a dominant design have higher survival rates, with this advantage increasing the earlier they enter (Suarez and Utterback, 1995; Christensen et al., 1998; Bayus and Agarwal, 2007).

Empirical regularities in the evolutionary economics literature

Evolutionary economics research has connected systematic shifts in technological characteristics and innovation sources to the different stages of industry evolution (Agarwal and Tripsas, 2008). The stylised facts which emerged are presented below.

Number of firms, entry, and exit. Evolutionary economics research, beginning with Gort and Klepper (1982), has consistently observed patterns in the numbers of firms, entry, and exit trends within industries over time. Using panel data, studies have documented five distinct industry life cycle stages, as identified in Gort and Klepper's analysis of 45 product innovations. Klepper and Graddy (1990) further simplified these stages into key phases: growth, shakeout, and maturity. A key finding in these studies is the intensity of shakeouts and the resulting stabilization in firm numbers; on average, industries saw a 40% decline from their peak, with some experiencing drops exceeding 70%. Additionally, evidence from Gort and Klepper (1982) and further analysis by Agarwal and Gort (2001) suggest that the industry life cycle may be shortening over time, with competitive entry now occurring sooner than in the past.

Klepper and Miller (1995) and Agarwal and Gort (1996) found that gross entry trends peak early in an industry's growth stage, while gross exit trends peak during the shakeout phase. These patterns have been consistently observed across various industries, both consumer and industrial, and in sectors with differing levels of technological intensity (Lieberman, 1990; Audretsch, 1995; Klepper and Simons, 2000b; Filson, 2001; Agarwal and Bayus, 2002).

Evolutionary economics studies highlight innovation and technological change as primary drivers of industry evolution, with major innovations typically introduced early in the life cycle (Gort and Klepper, 1982). Jovanovic and MacDonald (1994a, b) modelled innovation by industry leaders as an incentive for competition, while imitation by later entrants and eventual failure to innovate drove shakeouts. Audretsch (1995) noted that smaller firms show higher innovation rates during growth phases, reflecting 'entrepreneurial regimes' in manufacturing. Overall, evolutionary economists observe that later-stage innovations tend to be incremental rather than disruptive.

Agarwal (1998) studied patent trends across 33 industries and found that patent activity initially rises but then declines over time, a trend seen in 75% of high-tech industries compared to 55% in others. Notably, in technologically intensive industries, patenting activity often peaked after the number of firms had already reached its highest point.

Though evolutionary economists have rarely focused on product versus process innovation rates, some studies do explore these patterns. Klepper and Simons (1997) found that in the automobile industry, product innovation peaked early in the 20th century, while process innovation peaked later, notably with Ford's moving assembly line in 1913–14. In contrast, Filson (2001), examining five high-tech industries, found no evidence that product innovation is concentrated early in the life cycle and process innovation later, as quality improvements continued steadily over time.

Klepper and Simons (2000a) found that firms entering an industry with prior relevant experience, like radio producers entering the television industry, demonstrated higher rates of product and process innovation. These pre-entry capabilities significantly influenced the industry's evolution.

Furthermore, evolutionary economics studies reveal a consistent pattern in industry sales, with initial growth followed by a slowdown in output growth. Gort and Klepper (1982) and following researchers observed this trend across more than 50 industries, showing remarkable consistency (Klepper and Graddy, 1990; Jovanovic and MacDonald, 1994; Klepper, 1997; Agarwal, 1998; Filson, 2001; Agarwal and Bayus, 2002).

In most new industries, a 'take off' point marks the first major sales surge, though the timing varies widely. Some industries reach this point within five years, while others take over 20 years (Mahajan, Muller, and Bass, 1990; Golder and Tellis, 1997; Agarwal and Bayus, 2002). In their study of 30 new industries, Agarwal and Bayus (2002) observed a distinct 'hockey-stick' pattern in both firm numbers and sales, with firm growth consistently preceding sales take off. On average, firm take off occurred six years after commercialization, followed by sales take off eight years later. By the time significant sales began, about 44% of potential competitors had already entered the market.

Studies in evolutionary economics show consistent price trends across industries: prices tend to drop sharply in the first five years and then decline at a slower rate as the industry matures (Gort and Klepper, 1982; Klepper and Graddy, 1990). This pattern is supported by other studies indicating an exponential decline over time, although the rate varies by industry (Jovanovic and MacDonald, 1994; Agarwal, 1998; Klepper and Simons, 2000; Bayus, 1992; Bass, 1995). Agarwal and Bayus (2002) found that price declines were slower in high-R&D industries, suggesting a correlation between price trends and technology intensiveness.

In the past decade, research on firm survival within industry life cycles has expanded, focusing on firm-specific characteristics alongside environmental factors. Studies in evolutionary economics, even if related to first mover and entry timing advantages, emphasize the survival benefits of early entry in an industry's life cycle (Agarwal and Gort, 1996; Klepper and Simons, 2000; Agarwal et al., 2002). Additionally, this research examines how entry timing and life cycle stages influence the relationship between firm and industry characteristics and overall performance.

Studies using hazard rate analysis show a link between firm survival and age, with many studies indicating that hazard rates decline steadily with age (Klepper and Simons, 2000a; Klepper, 2002). However, the industry life cycle can alter this pattern. Agarwal and Gort (1996) found that early entrants faced a nonmonotonic hazard rate, initially rising, then declining, and eventually increasing again, which they called "senility." In contrast, later entrants had the highest hazard rates immediately post-entry, which declined with age but also increased after a certain period.

Research on firm performance and size within industry evolution shows a generally positive link between firm size and survival or market share (Klepper and Simons, 2000; Agarwal et al., 2002; Sarkar et al., 2006; Bayus and Agarwal, 2007). However, size-related disadvantages vary with the industry life cycle and technological intensity. While Lieberman (1990) found small firms are more likely to exit in the decline stage, other studies suggest that smaller firms face higher survival challenges during the growth phase than in maturity (Agarwal, Sarkar, and Echambadi, 2002).

Empirical regularities in the organization ecology literature

Organizational ecology research explores how social environments influence industry evolution, particularly focusing on changes in organizational populations. Although not centred on technological change, this field provides insights into factors affecting entry rates, the number of firms in an industry, and organizational survival over time.

Organizational ecology studies reveal a common pattern in industry evolution: organizational populations start low, rise rapidly, peak, and then decline as industries mature. This trend has been observed across various sectors, including labour unions, newspapers, and technology industries like telephones, fax machines, and microprocessors. Researchers also found an inverted U-shaped relationship between entry rates and population density – initial growth in organizations spurs more entries due to legitimization, but high density eventually limits entry due to competition. For instance, Baum, Korn, and Kotha (1995) observed that entry rates in the facsimile transmission service organizations grew until a dominant design was established, after which entry slowed; this effect faded within a few years of the design standardization.

In addition, a key focus is on factors affecting organizational mortality, especially the density-mortality relationship. Studies consistently find that as industry density increases, failure rates initially drop but then rise, showing a U-shaped pattern (Hannan and Freeman, 1988; Carroll and Hannan, 1989). Agarwal, Sarkar, and Echambadi (2002) found that this pattern varies with the industry life cycle stage, appearing during growth but not in firms transitioning from growth to maturity. Firm characteristics like age and size also affect survival: younger and smaller firms face higher failure rates (the "liability of newness" and "liability of smallness"), while there is also evidence for a "liability of adolescence" and "liability of senescence" as firms mature.

2.3. Theoretical Perspectives

The previous section outlined consistent patterns in industry evolution across various innovations and sectors, though it did not investigate into the theoretical perspectives guiding these observations. This section now compares the three main theoretical frameworks – technology management, organizational ecology, and evolutionary economics – highlighting their complementary or contrasting explanations of key industry evolution concepts (Agarwal and Tripsas, 2008).

High early entry rates in industries are explained by each research stream with different drivers. Early theories suggest that high technical uncertainty initially favours small-scale, experimental R&D, enabling small firms to enter and compete, as large firms lack a scale advantage (Mueller and Tilton, 1969). Similarly, technology management literature emphasizes the need for small-scale experimentation to understand user preferences (Utterback and Abernathy, 1975).

Evolutionary economists explain early industry entry as driven by favourable external information. Gort and Klepper (1982) describe how, early on, external knowledge ("type 2 information") outweighs incumbent knowledge, attracting new entrants. As the industry matures, incumbents gain an edge through accumulated experience and routines ("type 1 information"). Winter (1984) further distinguishes between an early "entrepreneurial regime," which favours radical innovation from entrants, and a later "routinized regime," favouring incumbent innovation. Shane (2001) supports this, showing that the technological regime influences whether universities license technologies to start-ups or established firms.

Organizational ecology attributes early industry entry to social processes. As the number of firms (density) grows, it boosts social and political legitimacy, attracting resources that encourage further entries (Hannan and Freeman, 1987). Various factors contribute to this legitimization, such as regulation, labour unions, resource availability, social dynamics, and cultural perceptions (Dobbin and Dowd, 1997; Haveman and Cohen, 1994; Carroll and Swaminathan, 2000; Hannan et al., 1995).

All three literature streams recognize industry shakeouts, though they offer differing explanations. Technology management scholars, particularly Utterback and colleagues, link shakeouts to the emergence of a dominant design, which ends product experimentation and encourages standardization. This dominant design brings firms to achieve economies of scale, invest in process innovation, and increase the minimum efficient production scale. Firms unable to adapt to the dominant design or restructure accordingly tend to exit or merge, leading to an industry shakeout (Abernathy and Utterback, 1978; Utterback and Suarez, 1993). Evolutionary economists use formal models to explain shakeouts but disagree on whether dominant designs are a cause or consequence of this process. Jovanovic and MacDonald (1994b) suggest that shakeouts occur when firms fail to adopt a superior technology, effectively invoking the concept of a dominant design; firms unable to transition face production inefficiencies and are forced to exit due to competitive pricing pressures. Klepper (1996) proposes that a dominant design results from the shakeout process itself. In his model, firms enter an industry with various technologies, competing in product and process innovation. Larger, established firms gain efficiency in product innovation due to increasing returns from R&D, while lower start-up costs initially allow for easy entry by innovators. Over time, however, incumbents' R&D and process innovations give them an advantage, raising entry barriers and pushing out less efficient firms. This shakeout phase reduces variation in product designs, ultimately leading to the emergence of a dominant design.

Organizational ecologists link shakeouts to a changing balance between legitimization and competition. As the industry's population density grows, competitive pressures intensify and begin to outweigh legitimacy benefits, leading to resource scarcity. This results in fewer new firms entering and more exiting, causing a shakeout. Additionally, models suggest that firms are influenced by the "founding density" – the density at the time they entered. Higher founding density, associated with resource scarcity, increases failure rates as firms struggle to survive under these conditions (Hannan and Freeman, 1989; Carroll and Hannan, 1989). Organizational ecologists do not emphasize dominant design emergence in explaining entry and exit patterns, but scholars in technology management and evolutionary economics suggest that a dominant design is not necessarily the best technological option. Instead, social, institutional, and economic factors guide its selection. Van de Ven and Garud (1993) propose a framework involving institutional standards, resource endowments, and firm activities as key influences. Garud and Rappa (1994) suggest that evaluation routines help select specific technological variants, while Rosenkopf and Tushman (1998) highlight the role of technical communities in shaping dominant designs, as seen in flight simulators. Kaplan and Tripsas (2008) further propose that cognitive alignment among producers, users, and stakeholders also drives convergence towards a dominant design.

In exploring firm survival, technology management scholars link higher survival probabilities to early entry relative to the establishment of a dominant design. Suarez and Utterback (1995) suggest that firms entering before the dominant design emerges gain an advantage by accumulating assets, shaping the design's development, achieving economies of scale, and establishing entry barriers, all of which enhance their survival prospects.

Evolutionary economists attribute firm survival to innovation sources and entry timing. Early entrants in the growth stage have higher survival chances, benefiting from demand growth and often leading in innovation (Agarwal and Gort, 1996). Firms diversifying from related industries also tend to enter early, leveraging their superior capabilities and existing resources for competitive and survival advantages, described as "dominance by birthright" (Klepper and Simons, 2000a). Evolutionary studies further suggest that life cycle stages impact survival factors, as entry barriers can act as survival barriers, with industry structure and firm diversity shaping survival outcomes (Agarwal, Sarkar, and Echambadi, 2002).

Organizational ecologists emphasize density dependence in firm survival, suggesting that firms entering during resource-rich periods have better survival chances than those entering in resource-scarce, high-density periods (Hannan and Freeman, 1989). Additionally, resource-partitioning theory explains survival in mature industries, where generalist firms compete centrally, allowing specialists to occupy niche markets. This theory predicts lower failure rates for specialists in these niches (Carroll, 1985). Khessina and Carroll (2002) found that startups in the optical disk drive industry targeted the latest technologies, while incumbents and diversifying firms competed across a broader range, similar to Bayus and Agarwal's (2007) findings in the personal computer industry.

2.4. Diffusion of Innovation/ Market Growth

A framework for understanding new product diffusion highlights four major factor groups influencing both first-time and repeat purchases: adopter, innovation, firm, and environment characteristics. Adopter characteristics include: class, risk tolerance, geodemographics, economic needs, and word-of-mouth behaviour. Innovation characteristics include: the product's relative advantage, price, perceived usefulness, ease of use, and network effects. Firm characteristics involve: the company's size, marketing efforts, and reputation. Environmental factors, such as infrastructure, availability of related products, and broader market conditions, shape customer adoption (Shankar, 2008).

Initial purchases are key, as they lead to repeat purchases and influence the product's sales revenue, profits, and the firm's overall value (Sorescu, Chandy, and Prabhu, 2003). Toward the end of a product's life cycle, a replacement product or technology emerges, driven by these same foundational factors.

A population of adopters includes five classes – innovators, early adopters, early majority, late majority, and laggards – each with varying risk tolerance, geodemographic traits (such as location, age, income, and education), and perceived economic value of the innovation (Rogers, 2003). Adopter characteristics and word of mouth influence innovation uptake. Key innovation characteristics include relative advantage, or functional superiority, and relative cost, both of which are crucial for adoption success (Rogers, 2003). The Technology Acceptance Model (TAM) highlights perceived usefulness and ease of use as primary drivers of technological adoption (Davis, 1989), while network externality – where an innovation's utility grows with its user base – also impacts sales (Katz and Shapiro, 1985; Shankar and Bayus, 2003).

Firm characteristics, such as size and reputation, play a role in new product adoption; larger, reputable firms can leverage resources to promote trials and influence potential adopters. Marketing efforts impact both trial and repeat purchases. Environmental factors, such as technological and economic infrastructure, availability of related products, market conditions, and competitor responses, also shape adoption rates.

Various models capture the diffusion of new products, with some focusing on product categories (e.g., Bass, 1969) and others on specific brands (e.g., Parker and Gatignon, 1994). Most models emphasize first purchases, while some also consider repeat purchases and the effects of marketing factors like price and advertising, others forecast market evolution across countries (Shankar, 2008).

First purchase diffusion model

The Bass (1969) model serves as the foundational framework for predicting first purchases, emphasizing innovation and imitation as drivers. Subsequent models have expanded on the Bass framework to handle multi-generational technology diffusion (Norton and Bass, 1987) and interdependent product categories (Bayus, 1987). Kim, Chang, and Shocker (2000) developed a model for inter-category and technology substitution, successfully predicting sales in telecommunications. Gatignon and Robertson (1989) identified factors like supply intensity and information processing that drive organizational innovation adoption, while Sinha and Chandrasekharan (1992) proposed a split hazard model to predict adoption timing and probability. At the individual level, Chatterjee and Eliashberg (1990) introduced a micromodel for adoption influenced by readiness and price sensitivity.

Consumer behaviour studies also indicate that prior knowledge and interface functionality shape adoption perceptions. Moreau, Lehmann, and Markman (2001) found experts favour continuous innovations but struggle with discontinuous ones without extra knowledge. Ziamou (2002) showed that consumers experience less uncertainty with new functionality, but that visualizing use can increase or decrease adoption uncertainty depending on the functionality's familiarity.

Repeat purchase diffusion model

The LRK model by Lilien, Rao, and Kalish (1981) captures both first and repeat purchases in product diffusion, using Bayesian estimation to integrate marketing influences like detailing and word of mouth. This model stands out because it systematically incorporates information from similar products, updates parameter estimates as new data arrive to refine forecasts and control strategies, and enables dynamic adjustment of optimal marketing strategies early in the product life cycle, even when historical data are limited.

Building on the LRK model, Rao and Yamada (1988) developed a method for forecasting drug sales as a function of marketing efforts, considering adoption as a repeat purchase diffusion process influenced by marketing and word of mouth. Tested on data from 19 drugs across physician types, the model showed promising but inconclusive results, with challenges in estimating market potential. Hahn et al. (1994) proposed a four-segment repeat purchase model with constant repurchase rates but lacked competitor effects. Parker and Gatignon (1994, 1996) included competitor effects but omitted repeat purchases. Shankar, Carpenter, and Krishnamurthi (1998) advanced these models by integrating competitor effects in a brand-level repeat purchase model, finding that innovative late entrants can outperform pioneers by achieving higher market potential, growth rates, and repeat purchase rates.

Product Life Cycle (PLC)

Sales of new product categories increase over time, progressing through various stages of the product life cycle (PLC). Numerous studies have explored different facets of the PLC, including work by Lilien and Weinstein (1981), Lambkin and Day (1989), Bayus (1998), Agarwal and Bayus (2002), Tellis, Stremersch, and Yin (2003), Lam and Shankar (2008), and Shankar (2008).

In a longitudinal study, Redmond (1989) analysed market concentration across the product life cycle, finding that pioneer firms using a skim pricing strategy led to lower market concentration in the growth stage, levelling out to similar concentrations as penetration pricing markets by maturity. Initial price effects did not impact market concentration beyond maturity. Golder and Tellis (1997) identified price as crucial for sales take off, whereas Agarwal and Bayus (2002) argued that shifts in supply and demand drive sales take off. Using Cox's model, they observed slow initial growth followed by take off in sales and competitors, with firm take off preceding sales take off, and firm characteristics outweighing price in explaining take off timing. The research highlights that early entrants in markets base their decisions on anticipated rather than actual sales, with non-price factors driving early demand shifts.

Tellis, Stremersch, and Yin (2003) find that, on average, sales take off happens six years post-launch, occurring faster for entertainment than for household products and earlier in Scandinavian compared to Mediterranean countries. Marketing strategies, whether 'pull' or 'push,' vary based on advertising spending over the product life cycle (PLC), though prior studies show mixed results on the impact of the PLC on advertising. Tellis and Fornell (1988) note that higher product quality boosts advertising more in mature stages. Shankar (2008) indicates that dominant brands shift spending to the sales force in mature PLC stages, while weaker brands focus on advertising, with dominant brands influencing weak brand spending asymmetrically. Lam and Shankar (2008) observe that early adopters of technology differ from late adopters in knowledge and motivation, with trust impacting loyalty for both, but satisfaction driving loyalty more for late adopters.

Diffusion in the international context

Research on new product evolution in international markets highlights two main strategies for market entry: international market scope, which refers to a brand's exposure across various countries, and speed of rollout. Large firms often distribute their brands widely, targeting markets with diverse potentials. For rollout speed, brands may choose a sprinkler strategy (fast rollout across multiple countries simultaneously) or a waterfall strategy (sequential market entry over time). Heeler and Hustad (1980) examined the Bass model's forecasting accuracy for international sales across 15 products but found it unreliable when based on limited sales data, as it often poorly predicted peak sales timing.

Gatignon, Eliashberg, and Robertson (1989) adapted the Bass model to analyse innovation diffusion at the individual country level using European data. Their model allows for variation in diffusion parameters across industries and applies a multi-country, multi-time-series approach to estimate the factors influencing diffusion across countries and time periods. This model leverages data from other countries (international market scope) to forecast innovation penetration in specific markets, accounting for unique country differences. They found systematic diffusion patterns across innovations and countries, identifying significant similarities and differences among international markets.

Research on the diffusion of consumer durables across countries reveals varied impacts of market entry timing, strategy, and country characteristics. Takada and Jain (1991) show that imitation increases with delayed product introductions between countries. Putsis et al. (1997) found that initial launches in larger European markets like Germany, France, Italy, and Spain maximize subsequent adoption. Dekimpe, Parker, and Sarvary (2000) identified two diffusion stages in global cell phone adoption: trial and confirmation. Talukdar, Sudhir, and Ainslie (2002) revealed faster peaks in sales for developed countries, with country traits influencing penetration. Stremersch and Tellis (2004) found that economic wealth explains growth rate differences in consumer durables across Europe. Gielens and Steenkamp (2004) noted that products with high or low novelty excel, with success influenced by brand strength, prior international introductions, and marketing support. Fischer, Shankar, and Clement (2005) showed that for late movers, broader international reach reduces entry penalties, while a waterfall rollout enhances marketing efficacy, supporting the advantage of sequential international entry.

New Product Entry Strategy

A new product's market success relies on its entry strategy and how incumbents respond to its entry. Key factors influencing entry strategy and competitor response include characteristics of the entrant, incumbents, and the market or industry. Entry strategy includes choices in product line length, pricing, advertising, and distribution, which shape the new product's competitive position. The framework, adapted from Shankar (1999), provides a structured approach to analyse these interrelationships and the drivers behind competitor reactions. Eliashberg and Jeuland (1986) propose an optimal pricing model for a new durable product anticipating future competition, revealing that a nonmyopic monopolist (who anticipates competition) sets a lower penetration target and higher initial prices than a myopic monopolist. When competition begins, the first entrant reduces its price compared to the monopoly period. Identical competitors use steadily declining prices, while differences in costs or customer response parameters lead to divergent pricing strategies. Mamer and McCardle (1987) model innovation decisions under competition and uncertainty, showing that potential competition from substitute technologies reduces the likelihood of adopting an innovation. In the PDA industry, Bayus, Jain, and Rao (1997) find that in competitive, symmetric conditions, firms enter at different times with distinct performance levels, while in asymmetric conditions, the firm with a higher market size estimate or better development process enters first.

Moorthy and Png (1992) suggest that sequential product introduction is better than simultaneous introduction when customer impatience and cannibalization are concerns, but it is less effective if the seller can pre-commit. Williams (1983) identifies a shift in competitive focus from product to process technology over time, leading to a market where prices may fall below production costs, necessitating structural changes for firms. Carpenter and Nakamoto (1990) provide strategies for late movers entering a market dominated by incumbents, focusing on price, advertising, and distribution. Gatignon, Weitz, and Bansal (1990) find that in brand introductions, communication efforts are shaped by available resources and market conditions, with superior quality and market growth as key success factors. Hendricks and Singhal (1997) analyse delays in product launches, finding that delay announcements reduce firm market value by 5.25%, with industry competitiveness, firm size, and diversification influencing the impact.

Shankar, Carpenter, and Krishnamurthi (1999) analyse the impact of a brand's product life cycle (PLC) entry stage on its sales growth and market response, showing that growth-stage entrants experience the fastest growth and greater sensitivity to product quality. Pioneers benefit most from advertising and sales force response, followed by growth-stage and then mature-stage entrants. Shankar (1999) finds that both new product introduction and incumbent response strategies influence each other, with larger incumbents deterring new brands' spending more than smaller ones. Multimarket contact reduces both spending on introductions and incumbents' competitive responses. Van Heerde, Mela, and Manchanda

(2004) reveal that the introduction of an innovative brand, using frozen pizza data, temporarily raises market uncertainty, increases cross-price elasticity among existing brands (indicating stronger substitution effects), and raises existing brands' price sensitivity while reducing brand differentiation.

Banbury and Mitchell (1995) stress the significance of incremental product innovation in established industries, finding that effective and rapid incremental innovation boosts market share and enhances business survival. Introducing these innovations provides incumbents with a stronger competitive advantage and protection from new entrants, while early adoption of competitors' innovations offers a smaller advantage. Mahajan, Bretschneider, and Bradford (1980) propose adaptive modelling to better estimate decision variable effects in market response, useful for identifying structural shifts in unknown timings. Mahajan, Sharma, and Buzzell (1993) suggest a simplified model for assessing how new product entries affect market size and incumbent sales, noting that the model's limitation is its exclusion of pricing and advertising impacts.

Competitive responses to new product entry

Competitor response to new product entry is critical in shaping market evolution, with normative models offering strategies for incumbents. Hauser and Shugan (1983) suggest that in a static market, incumbents should reduce advertising and distribution spend, lower prices, enhance product quality, and reposition toward their strengths. They also developed the *Defender* model for guiding incumbent marketing strategies. Kumar and Sudarshan (1988) similarly find that optimal defensive strategies involve reducing prices, advertising, and distribution. Gruca, Kumar, and Sudarshan (1992) highlight that response strategies depend on market dominance: dominant incumbents should increase spending, while nondominant brands should reduce it.

Descriptive models examine competitor reactions to new product entries across industries using econometric analyses. Robinson (1988) finds that incumbents in oligopolistic markets generally delay their response to new entrants, with more aggressive reactions occurring in the second year. Shankar (1997) analyses how pioneers adjust their marketing mix upon new entry, noting that the type of competitive game and anticipated effects on margins and elasticities strongly influence reactions. Pioneer responses depend on their competitive position, elasticity shifts, and market conditions. Bowman and Gatignon (1995) find that competitor reaction times are longer when switching costs, the entrant's market share, and product development time are high, but are shorter with high market growth, larger market share of the incumbent, and rapid technological change.

MacMillan, McCaffery, and Van Wijk (1985) find that competitor response times to easily imitable products are influenced by factors like visibility, potential, complexity, and strategic approach. Gatignon, Robertson, and Fein (1997) show that quick responses to new entrants improve defence success, but using too many marketing tactics decreases effectiveness. Kalra, Rajiv, and Srinivasan (1998) propose that delayed responses to competitive entries may be optimal when the new product's quality is uncertain, as an immediate price cut could signal high quality to consumers. Kuester, Homburg, and Robertson (1999) reveal that innovative rival products prompt slower but reciprocal reactions, while market growth speeds up retaliation, particularly in product mix adjustments. In concentrated markets, firms react less aggressively and slowly, and larger incumbents tend to respond more slowly and with less intensity.

Debruyne et al. (2002) found that most competitor responses to launches occur through price adjustments, while changes in product assortment, promotion, and distribution are less common. Radical innovations and niche-targeted products often go unchallenged, while competitors react more to products that fit existing categories, especially in high-growth markets and when heavily advertised. Heil and Walters (1993) show that market signals – hostility and consequence – strengthen competitor reactions, with hostility having the most influence. Robertson, Eliashberg, and Rymon (1995) find that incumbents are more likely to react if they have high fixed commitments, operate in high-patent industries, and view signals as credible but not overly hostile, favouring alternative marketing tactics over product-based reactions in these scenarios.

Hultink and Langerak (2002) present a framework linking competitive reaction to perceived market signals from new product launch strategies like targeting, pricing, advertising, and product advantage. They find that high advantage products and strategies like penetration pricing and intensive advertising are seen as hostile, especially in fast-growing markets, prompting stronger reactions. Broad targeting, however, is not viewed as hostile, even for aggressive entrants. Hostility and commitment signals increase reaction strength, while consequence signals speed up reactions. Shankar (2006) analyses proactive and reactive responses in the computer printer market, finding that market leaders, unlike followers, have stronger reactions than anticipations in price, distribution, and product line adjustments. Leaders also exhibit greater product line sensitivity than followers.

2.5. Sub-markets Role in Industry Evolution

Latent submarket dynamics

The concept of niches, or submarkets, has recently gained attention in economic modelling, challenging the traditional view where firms are assumed to produce a single product among many similar alternatives. Submarkets, in contrast, are distinct areas within an industry, isolated on both demand and supply sides, allowing firms to participate in multiple submarkets, which can emerge or disappear over time. This dynamic nature influences firm entry, exit, growth, and decline and has been highlighted as significant in various industries. Submarket models help explain the effects of disruptive technologies, patterns in firm size, innovation, patenting rates, and firm growth and exit (Bhaskarabhatla and Klepper, 2014). Bhaskarabhatla and Klepper (2014) examine how submarket dynamics influence industry market structure and innovation. Building on Klepper and Thompson's (2006) submarket evolution model, they propose that independent submarkets can become substitutes if advancements in one make it dominant, sparking an increase in R&D and creating an integrative submarket. This shift can drive industry-wide transformations, including shakeouts. Applying this model to the US laser industry, they show how a major technological breakthrough in the late 1980s led to a consolidation of laser submarkets and a significant shakeout of producers, highlighting distinct phases of growth, innovation, entry, and exit. The authors illustrate how submarket dynamics can drive sudden changes in the evolution of industries, using the concept of an "integrative submarket," similar to the idea of a dominant design, to explain shakeouts. While the dominant design theory also addresses shakeouts, their submarket theory offers a broader explanation for the unique patterns observed in the laser industry. They also evaluate other shakeout theories, identifying limitations in explaining the laser industry's empirical patterns. Additionally, they discuss generalizing their model to other innovative industries with similar shakeouts, like hard disk drives and automobiles.

For centuries, the laser industry saw steady growth, with new laser types and variants attracting new firms and users. However, the introduction of DPSS lasers around 1988 marked a turning point. Technological advancements in DPSS lasers increased their popularity, leading them to compete with other laser types and forcing many producers to exit. Concurrently, solid-state laser producers faced a shakeout, significantly reducing their numbers and resulting in an industry-wide shakeout that continues today (Bhaskarabhatla and Klepper, 2014).

Before DPSS lasers emerged, early entrants in the laser industry showed no clear competitive advantage. However, with the rise of DPSS lasers, early entrants, especially leaders like Spectra Physics and Coherent, began to outperform later entrants due to their larger scale, allowing them to better absorb R&D costs and lead in innovation. Coherent's CEO, John Ambroseo, noted that the industry’s shift to mainstream applications required firms to reach a critical size, driving consolidation.

The shakeout in the laser industry appears fundamentally linked to technological change, unlike theories that attribute shakeouts to demand dynamics alone. While demand-side theories suggest that superior early entrants survive longer due to initially challenging market conditions, the laser industry’s early phase showed no such survival advantage until DPSS-driven innovations created it, stressing the central role of technology in the subsequent shakeout (Bhaskarabhatla and Klepper, 2014).

Unlike the dominant design theory, where demanders eventually align on a specific product design, leading to focused competition and a shakeout, the concept of an integrative submarket captures a convergence toward a single technology driven by scientific innovation rather than customer preferences. In the laser industry, scientists developed ways to use laser light with solid-state crystals, leading to diverse solid-state laser types rather than a single dominant design. The integrative submarket theory thus provides a more comprehensive explanation for industry-wide and submarket shakeouts, accounting for dynamic patterns in the laser industry that dominant design theory cannot fully explain (Bhaskarabhatla and Klepper, 2014).

The concept of an integrative submarket is versatile, applying to shakeouts driven by technological, regulatory, or demand-side changes. Its relevance lies not in a purely technology-focused view but in whether a submarket fosters an R&D escalation process, as theorized by Sutton and Klepper. Submarket dynamics are therefore broader than technology dynamics, as independent submarkets may align with a technological trajectory without being solely defined by it (Bhaskarabhatla and Klepper, 2014).

In contrast, Jovanovic and MacDonald's shakeout theory highlights how technological advancements can raise production scale economies and the minimum efficient firm size, limiting producer numbers – similar to the impact of dominant designs. However, in the case of DPSS lasers, leading firms thrived by innovating a variety of laser types rather than scaling production of a single type, suggesting that success was rooted in diversity of innovation rather than economies of scale (Bhaskarabhatla and Klepper, 2014).

Tong's (2009) shakeout model, based on independent submarkets, shares similarities with the authors' theory. In Tong's model, shakeouts occur separately within submarkets over time, with overall industry stability maintained until new submarkets emerge. An industry-wide shakeout only occurs when submarket creation slows. However, in the laser industry, the rise of solid-state lasers disrupted this independence as they began to compete with gas and dye lasers, indicating a shift toward interdependent submarkets (Bhaskarabhatla and Klepper, 2014).

The laser industry's evolution, especially the role of the integrative submarket, highlights how such shifts can drive shakeouts and change innovation dynamics – a pattern seen in other industries, like hard disk drives. Initially, smaller drives created new submarkets and were overlooked by industry leaders due to their perceived limited appeal. However, as these smaller drives improved, they attracted users of larger drives, leading to a major shakeout where new entrants overtook incumbents. This example aligns with the proposed model, where early developers of a new submarket gain enough scale to profit from R&D, driving transformative industry changes (Bhaskarabhatla and Klepper, 2014).

The US automobile industry also illustrates how submarket dynamics can drive a shakeout. Initially, various car types and engine technologies coexisted, catering to different consumer segments. Ford's Model T, introduced in 1908, created an integrative submarket appealing broadly to both urban and rural buyers, allowing Ford to invest in cost-cutting innovations like the assembly line, leading to a shakeout shortly afterward. Similar dynamics were seen in the US tire industry (Bhaskarabhatla and Klepper, 2014).

In contrast, industries like TV receivers and penicillin experienced early shakeouts due to a lack of independent submarkets, with little product differentiation on the supply side. This led firms to compete on cost-reduction from the beginning, accelerating the shakeout. The model can accommodate such cases by assuming that cost-reducing R&D applies across all products, fostering early competition and shakeouts (Bhaskarabhatla and Klepper, 2014).

Submarket dynamics can also fragment industries. For instance, post-World War II, the camera industry initially converged around a single type for both hobbyists and casual users, later splitting into two submarkets, renewing entry and product innovation. This example shows that industries can fragment or integrate over time, impacting entry, innovation, and the likelihood of a shakeout (Bhaskarabhatla and Klepper, 2014).

The Impact of Submarket Convergence on Incumbent-Entrant Dynamics

The literature on industry evolution has traditionally suggested that incumbents hold advantages over new entrants due to convergence towards standardized industry structures, favouring homogeneous production and stable oligopolies. However, recent studies have shifted focus to industries that remain segmented, where opportunities for entrants arise through niche markets and disruptive technologies. This segmentation allows for differentiated competences in submarkets, such as technological and customer-related skills.

Entrants can capitalize on this lack of convergence, gaining space in specific submarkets where incumbents lack certain competences (Uzunca, 2018).

To explain these dynamics, the study by Uzunca (2018) introduces a competence-based view, proposing that submarket boundaries should be defined by necessary competences – technological and customer-centric – within the same industry. It argues that the convergence of these competences across submarkets typically favours incumbents, but the lack of convergence allows entrants to disrupt by leveraging their specialized skills. This model was tested in the global semiconductor industry (by analysing over 17,000 observations), revealing that submarkets with convergence in both technological and market competences see more entrant exits, while non-converging submarkets allow entrants to survive longer (Uzunca, 2018).

Traditional theories of industry evolution largely focus on a single evolutionary path where incumbents dominate, often dismissing other patterns as anomalies. However, three distinct patterns can actually emerge: (1) dominance by incumbents, (2) disruption by new entrants, and (3) the sustained separation of submarkets. While these outcomes are not necessarily exclusive, convergence in submarkets tends to lead either to incumbent dominance or entrant disruption. The competence-based view of industry evolution explores how convergence in essential competences for producing and selling across submarkets can explain all three evolutionary outcomes (Uzunca, 2018).

Submarkets impose significant constraints on firms' learning, competences, and strategic activities, yet they are rarely used in strategic management to define boundaries for knowledge and competence exploitation. Examining the semiconductor manufacturing industry at the submarket level reveals structural shifts driven by rapid technological innovations that continuously improve semiconductors, creating growth opportunities for both incumbents and entrants. Distinct submarkets, each with unique process technologies or product functionalities, enable specialization and foster disruptive technologies, which might not survive in a more uniform industry. While the semiconductor industry appears mature, its submarkets remain dynamic, open to technological and market disruptions, challenging incumbents to adapt swiftly to these evolving threats (Uzunca, 2018).

Uzunca presents a different perspective on incumbent disruption by entrants than Christensen's (1997) model, which attributes disruption to incumbents' myopia in prioritizing current markets over emerging ones. Here, disruption is instead linked to incumbents' lack of necessary competences to serve distinct submarkets. Unlike Christensen's view, where incumbents are capable but fail to exploit new opportunities, this study suggests disruption arises from incumbents' actual incompetence in meeting diverse customer needs, aligning with Priem et al. (2012), who argue that incumbents' inability to notice demand challenges Christensen's "innovator's dilemma".

Understanding shakeouts in industries is challenging due to the difficulty in distinguishing when industries converge into homogeneous structures dominated by a few firms versus when they remain segmented and diverse. Traditional ILC models, which assume industries are homogeneous, miss the potential for varied evolutionary paths across submarkets. Uzinca explores these patterns in the semiconductor industry, showing that certain submarkets, like memory and logic, experience consolidation driven by standardization and scale economies, leading to dominance by incumbents. In contrast, submarkets like analogue, discrete, and MEMS remain segmented, supporting the survival of entrants who produce and sell distinct products for different customers. This dual pattern reveals that industry evolution can follow both consolidation and competition across different submarkets, offering insights into why shakeouts do not universally occur (Uzunca, 2018).

The concepts of technology and market closeness in this study offer new ways to understand industry relatedness in diversification and M&A research, potentially enhancing how corporate diversification and knowledge relatedness are measured. This approach also suggests that incumbents' strategic repositioning in response to disruptions deserves further attention. Rather than focusing solely on survival, research should examine a wider range of outcomes for incumbents, including significant changes in performance following disruptions (Uzunca, 2018).

The theory developed here applies to all industries, segmented or not, by focusing on submarket differentiation. In industries with multiple submarkets, like semiconductors, entrants can have an advantage by avoiding direct competition with dominant incumbents. Incumbents must understand their unique competences at the submarket level, such as technology or market knowledge. Industries with non-converging submarkets allow entrants to grow, while converging submarkets push industries toward homogeneity. The study emphasizes the need for incumbents to balance growth inside their submarkets while exploring new technologies and functionalities to respond to disruptive entrants, who can reshape industry dynamics by prompting incumbents to reposition (Uzunca, 2018).

This study advances research on how industry structures influence competition between incumbents and entrants. By analysing submarkets in depth, the study suggests that future work could develop this into a mathematical model or simulation, enhancing its predictive power. It also broadens the traditional monolithic view of industry evolution, integrating both incumbent dominance and entrant disruption into a more comprehensive theory. Future research could refine this framework to bridge Klepper’s model of incumbent dominance through shakeouts with Christensen’s theory of entrant disruption (Uzunca, 2018).

CHAPTER 3. The Context of Analysis: The e-cigs Industry

3.1 What are electronic cigarettes and how they work

In 2003, the first commercially successful e-cigarette was developed by Chinese pharmacist Hon Lik, whose aim was to create an alternative to conventional smoking. The device consists of three main components: a battery, an atomizer, and a cartridge that contains either a nicotine-loaded or nicotine-free liquid solution, also known as e-liquid. Upon activation, the battery heats the liquid within the cartridge, which the atomizer subsequently vaporizes into an inhalable mist. This process, known as vaping, is also associated with the use of analogous devices, including vape pens and e-hookahs. E-liquid formulations present significant variation. A standard e-liquid typically consists of propylene glycol and glycerine (95%), with the remaining 5% comprising a mixture of flavourings, nicotine, and other additives. These flavourings can be natural, artificial, or organic. The rapid evolution and the extensive variety of electronic cigarettes available on the market present challenges for a precise classification. Consequently, will try to offer a simplified, though not entirely comprehensive, categorization of electronic smoking devices.

First-generation e-cigarettes, often known as "cigalikes," were disposable devices designed to resemble traditional combustible cigarettes. As e-cigarettes evolved, new types emerged to enhance the delivery of nicotine from e-liquids. *Second-generation e-cigarettes* are larger, typically refillable, and use e-liquids. *Third-generation e-cigarettes*, also referred to as tanks or mods, are significantly larger, both refillable and rechargeable, and allow users to customize the substances and adjust the device's power for a stronger throat hit. *The fourth* *generation*, known as "Pod Mods," feature a prefilled or refillable pod cartridge integrated with a modifiable system (Ozga et al., 2022).

Inside a vaping device, the internal architecture comprises a logic board and an integrated circuit, resembling scaled-down versions of a computer's motherboard and processor. These components are governed by hard-coded programming known as firmware, which orchestrates the device's operations. The primary role of the logic subsystem in an electronic cigarette is to regulate the safe transmission of power from the battery to the heating element. To achieve this, the integrated circuit, in conjunction with the firmware, may implement various safety protocols, which include:

- *Automatic Timer*: this function prevents excessively long inhalations, which could lead to overheating.
- *Temperature Monitoring*: the device includes a mechanism to shut down if it reaches unsafe temperature levels, preventing thermal damage.
- *Battery Monitoring*: the system continuously checks the battery's voltage during both use and charging, ensuring that it operates within safe parameters.
- *Charging Management Circuit*: this circuit oversees the charging process, terminating it once the battery reaches full capacity to avoid overcharging.
- *Current Monitoring*: the device monitors the current drawn by the connected coil to ensure it does not exceed safe levels.
- *Resistance Checking*: the system verifies that the connected coil's resistance is within the device's supported range and that no short circuit is present.

Before the device begins to generate vapor, the safety subsystem must be activated (Ozga et al., 2022).

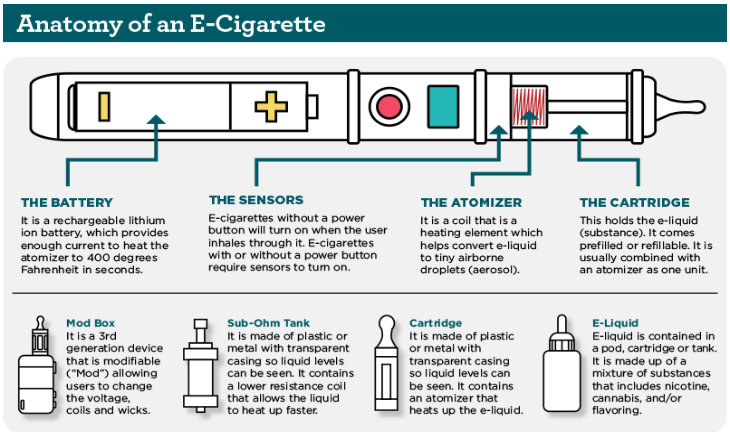
In most vaping devices, the top section typically has a thread for attaching a twist-on tank or a chamber designed for a drop-in capsule. In pod-based systems, this area usually includes one or more metal plates that establish an electrical connection with the inserted pod. For devices using a conventional reservoir, the threaded section contains a central spring-loaded pin designed to interface with a corresponding pin at the base of the reservoir. This pin, or point of contact, is designed to provide high electrical conductivity and is often made of gold-plated copper to improve performance (Bertholon et al., 2013).

A vape tank or pod comprises three primary components: the reservoir, the airflow system, and the coil assembly. The reservoir, typically constructed from glass or plastic, serves as the central body of the tank or pod and is responsible for containing the e-liquid. The airflow system includes the intake vent, located at the base of the tank or pod, and the chimney, which extends from the coil assembly to the mouthpiece. The coil assembly plays a crucial role in regulating the flow of e-liquid within the tank or pod, ensuring that the vape juice is supplied to the coil as needed while preventing leakage (Bertholon et al., 2013).

The coil assembly constitutes the central component of a vape tank or pod, with its primary elements being the wick and the heating element. Upon examining a vape coil, one will observe perforations along its sides, which reveal the white cotton wick within. E-liquid permeates the wick by passing through these perforations. Once the wick is fully saturated, a weak vacuum forms inside the tank or pod, effectively halting further e-liquid flow. This mechanism prevents the coil assembly from becoming flooded, which would otherwise result in leakage (Bertholon et al., 2013).

The heating element is the critical component responsible for vapor production within a vape coil. The wick is intricately wrapped around the heating element and functions to supply the element with e-liquid. Upon activation of the device, the heating element reaches a high temperature, vaporizing the e-liquid absorbed in the wick. The generated vapor then travels through the chimney and is expelled from the tank or pod via the mouthpiece. For a simplified visual representation, see Figure 3.1.

Figure 3.1: Anatomy of an E-Cigarette



Source: U.S. Department of Health and Human Services, Centres for Disease Control and Prevention- E-Cigarette, or Vaping, Products Visual Dictionary

Aside from water, the primary ingredient in e-liquid is typically propylene glycol (PG) mixed with water. When a user inhales, a mechanical sensor detects the action and activates a microchip that controls the heater, increasing the temperature within the vaporization chamber. According to manufacturer specifications, the temperature in the vaporization chamber generally ranges from 40 to 65°C. However, variable voltage devices have recently become popular due to their ability to increase the operating temperature and the surface area of the heater, allowing users to customize the vapor to their preferences (Bertholon et al., 2013). Currently, there is no reliable data available regarding the temperature ranges for these newer devices. Similarly, uncertainty persists about the operating temperatures in chambers that vaporize PG-glycerol mixtures or glycerol-only fluids, as glycerol requires a higher

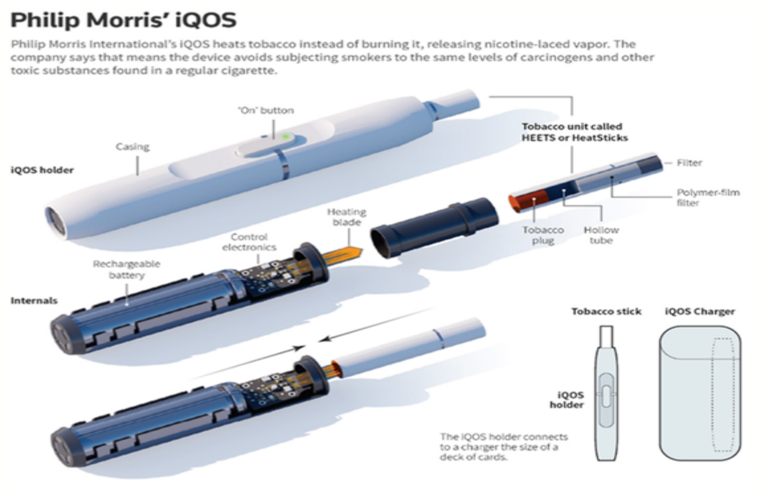
temperature to vaporize. Some manufacturers claim to cap the temperature at under 100°C to prevent the formation of toxic acrolein, which occurs at higher temperatures.
The aerosol is produced through vaporization at these temperatures, and the vapor subsequently condenses into a visible fog. This process is analogous to that of mist generators used in theatres, discotheques, or on movie sets. The droplets of PG or glycerol within the fog carry the flavouring chemicals and, if included, nicotine. The red LED at the tip of the e-cigarette lights up during inhalation (Bertholon et al., 2013).

Recently, dis*posable e-cigarettes*, such as "Puff Bar" or "Elf Bar”, have gained substantial popularity in the market. A notable distinction in disposable vaping devices with respect to rechargeable e-cigarettes is the concealed nature of the coil, which is inaccessible for replacement or e-liquid refilling after use. These devices are equipped with a pre-charged lithium-ion battery and a pre-filled internal tank. Consequently, once the e-liquid is exhausted or the battery depletes, the entire device be discarded.

Furthermore, during the 2010s, heated tobacco products (*HTPs*) were introduced. HTPs operate by heating tobacco leaves to approximately 350°C, a temperature that is sufficient to release nicotine and other compounds without combusting the tobacco. Unlike e-cigarettes, which utilize liquid nicotine as their nicotine source, heated tobacco products derive nicotine directly from the tobacco leaf.

Most HTPs function by warming tobacco-filled paper sticks. These sticks are inserted into a holder that contains a battery and a heating element. When the tobacco stick is placed in the holder, it encounters the heating element, which raises the temperature of the tobacco without reaching the point of combustion or producing smoke. Instead, the heated tobacco generates an aerosol containing nicotine, which is inhaled by the user. HTPs typically consist of three primary components, as illustrated in Figure 3.2 (representing the *IQOS* device by *Philip Morris International*), namely tobacco-filled sticks, a device holder and a charger.

Figure 3.2: HTP device



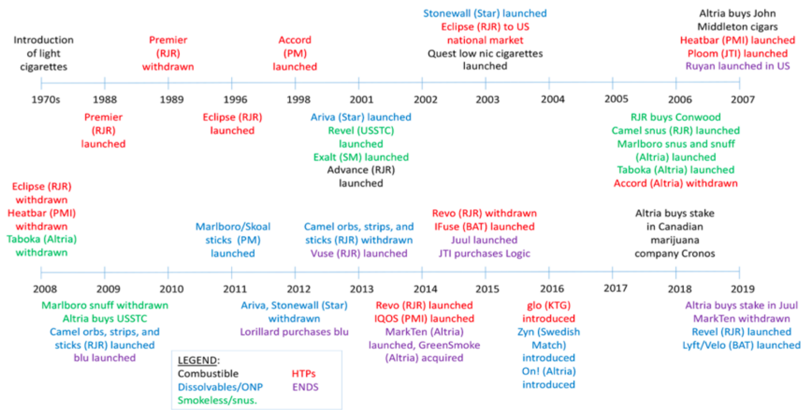
Source: California Department of Public Health, Introduction to Heated Tobacco Products

The user inserts the tobacco stick into the holder and activates the heating element by pressing a button, initiating the heating of the tobacco leaves within the stick. *IQOS* devices are pre-programmed to heat the tobacco stick for a duration of six minutes or for a maximum of 14 puffs, whichever occurs first. During this time, the user inhales the aerosol produced by the heated tobacco. Each tobacco stick is designed for single use, and with the *IQOS* system, the holder must be recharged after each use.

3.2. Innovation in the electronic cigarette industry

The global decrease in smoking poses difficulties for cigarette manufacturers, prompting them to adapt by creating or acquiring alternative products, and to try to transition their customer base to these alternatives, with varying degrees of success (Figure 1.3) (O'Connor et al., 2021).

Figure 3.3: Timeline of new product introductions by the tobacco industry, 1970–2019



Source: Tobacco Tactics

Figure 3.3. reports a timeline in the evolution of the industry. The first generation of e-cigarettes was engineered to closely replicate the appearance and experience of traditional cigarettes, offering a familiar design to smokers seeking an alternative to tobacco. These early "cig-a-likes" were constrained in terms of functionality and customization, yet they established the foundation for the subsequent development of more advanced and sophisticated models (O'Connor et al., 2021). Later versions introduced tank systems and mods, enabling users to refill their devices with preferred e-liquids and adjust power output for a more customized experience. Innovations like temperature control and sub-ohm vaping further enhanced and refined the overall user experience (O'Connor et al., 2021). With the expansion of the market, product diversity also increased. Pod systems, for instance, integrated the ease-of-use characteristic of earlier models with the enhanced performance of more advanced devices (O'Connor et al., 2021).

The evolution of e-cigarettes has been significantly influenced by the regulatory landscape. In response to concerns regarding public health and youth accessibility, manufacturers have been required to adapt to evolving regulations, resulting in the introduction of features such as child-resistant packaging and tamper-evident designs. Furthermore, the leading multinational tobacco companies have collectively embraced the concept of harm reduction, shifting their focus away from combustible cigarettes and advocating for a "smoke-free world." Notably, *Philip Morris International* (PMI) created a supposedly independent foundation to advance this idea, though its independence has been called into question (O’Connor et al., 2021).

The category of HTPs, which generally heat tobacco to temperatures below combustion to produce a nicotine-containing aerosol, can be traced back to *RJ Reynolds'* (RJR) introduction of the *Premier* in 1988. Premier used a charcoal tip that, when lit, generated heat, which passed through the device and created an aerosol that released both flavour and nicotine from flavour beads and a small amount of tobacco. However, Premier was unsuccessful in the market and was discontinued in 1989. RJR redesigned it as *Eclipse*, which launched in 1996. *Philip Morris* (PM) introduced a different approach in 1998 with the *Accord*, which featured an external heat source into which users inserted small cigarettes made from a specially formulated reconstituted tobacco blend (O’Connor et al., 2021).

These two technological approaches—charcoal tips and external heat sources—served as the foundation for later products such as RJR's *Revo*, launched in 2014 and discontinued in 2015, and *Philip Morris' Heatbar*, introduced in 2007 and withdrawn in 2008. These early models generally struggled to gain traction and were removed from the market shortly after their release (O’Connor et al., 2021).

In recent years, however, newer HTPs have seen greater acceptance among smokers. Products like *Japan Tobacco International*'s *Ploom* (launched in 2007), *Philip Morris International's*

IQOS (launched internationally in 2014 and in the USA by *Altria* in 2020), *British American Tobacco's iFuse* (introduced in 2015), and *Korea Tobacco & Ginseng's glo* (introduced in 2016) have successfully captured significant global market share (O'Connor et al., 2021).

Furthermore, since 2019, the market for disposable or single-use e-cigarettes has experienced rapid growth. In October 2023, industry analysts from ECigIntelligence estimated that these products constituted nearly 40% of the global e-cigarette market.

Single-use e-cigarettes have sparked significant controversy, primarily due to concerns regarding their increasing popularity among youth and their environmental impact, which has attracted widespread media attention. These concerns have led to warnings from health advocates and policymakers. Additionally, some major UK retailers have publicly announced they will cease selling single-use products.

Despite claims of sustainability, three of the four largest Transnational Tobacco Companies (TTCs) introduced new single-use e-cigarettes in 2022, citing consumer demand and a preference for convenience. However, the concept of single-use e-cigarettes is not novel, even for TTCs, as earlier versions, such as 'cig-a-likes' or pen-style products, were already on the market. As of early 2023, some of these older models continued to be marketed alongside the newer bar-style disposable products.

3.3. Key manufacturers

Starting in 2012, tobacco companies began acquiring existing e-cigarette brands and developing their own e-cigarette products. At that time, the global e-cigarette market was highly fragmented and primarily dominated by independent companies. Tobacco companies were strategically positioned to capitalize on this rapidly expanding market, given their established distribution networks and the financial resources necessary to support extensive marketing efforts. They were also well-equipped to handle the financial and legal challenges anticipated with future e-cigarette regulations.[1]

In 2012 and 2013, tobacco companies made significant investments in e-cigarettes in both the UK and the US, a trend that continued in the following years. By 2018, major companies such as *British American Tobacco* (BAT), *Imperial Brands*, *Japan Tobacco International* (JTI), and, to a lesser extent, *Philip Morris International* (PMI), had all established their own flagship e-cigarette brands and were actively expanding their presence in global markets.[1] Additionally, in 2018, *Altria* acquired a minority stake in the US e-cigarette manufacturer *JUUL Labs*. According to market research firm Euromonitor International, the e-cigarette market's value had surged, increasing from less than $5 billion in 2013 to over $20 billion by 2019[1].

3.3.1 British American Tobacco (BAT)

British American Tobacco (BAT) introduced its *Vype* e-cigarette in July 2013, a product initially developed by *CN Creative*, a start-up that BAT had acquired in December 2012 and later integrated into its *Nicoventures* division. Following the formation of a strategic partnership with the US tobacco company *Reynolds American Inc*. (RAI) in 2014, BAT fully acquired RAI and its *Vuse* e-cigarette line in 2017. BAT continued to acquire additional independent e-cigarette companies, expanding its product offerings under both the *Vype* and

[1] *E-cigarettes, Tobacco Tactics, updated 02 February 2023, accessed 12 August 2024*

Vuse brands. In 2020, BAT started to consolidate the two brands under the *Vuse* name and, in 2022, launched the disposable product *Vuse Go*. Market research firm Euromonitor International reported that in 2021, BAT held a 17.4% share of the global e-cigarette market. In September 2021, BAT announced that its flagship e-cigarette, *Vuse*, had achieved the highest global market share by value, based on sales in key markets including the USA, Canada, France, the UK, and Germany. In addition to e-cigarettes, BAT is also involved in HTPs, snus (a moist, powdered smokeless tobacco product, typically placed under the upper lip and absorbed through the gum), and nicotine pouches. Like other companies, BAT refers to its newer nicotine and tobacco products as 'next generation products' (NGPs), though its terminology for these products evolves over time.[2]

In 2012, it appeared that BAT planned to submit its e-cigarette, *Nicodex* (or a similar nicotine product, *Oxette*), to the UK Medicines and Healthcare products Regulatory Agency (MHRA) for classification as a medical product. However, BAT instead formed an agreement with a UK company, *Kind Consumer Limited*, to commercialize their nicotine inhaler, *Voke*. Although BAT announced this intention in 2014, the company had previously stated in 2013 that aligning e-cigarettes with medicines would increase complexity, raise research and development costs, and limit market access. BAT ultimately abandoned this plan and returned all rights to Kind Consumer in 2019.[2]

Acquisitions and Alliances

The *Vype* e-cigarette was developed by *CN Creative*, a British start-up company that BAT acquired in December 2012 for an estimated £30-50 million. Following the acquisition, CN Creative was integrated into BAT's Research and Development division and *Nicoventures*, a

[2] *E-cigarettes: British American Tobacco, Tobacco Tactics, updated 09 March 2023, accessed 12 August 2024.*

subsidiary established by BAT in 2011 to develop nicotine replacement therapy products. In the final two months of 2013, BAT invested £3.6 million in an advertising campaign for *Vype*, titled "Experience the Breakthrough," which included press, digital, and outdoor advertisements designed to raise awareness of *Vype* as an alternative to smoking tobacco. BAT asserted that its television and cinema advertising was conducted "responsibly," targeting only adult smokers and users of other nicotine products.[2]

However, with the introduction of new restrictions on e-cigarette advertising in the UK in 2016, including bans on television and cinema ads, BAT, like other tobacco companies, adopted more creative marketing strategies. These strategies included partnerships with artists, designers, musicians, and other celebrities, which in some instances led to public complaints.[2]

In July 2014, BAT established a strategic partnership with *Reynolds American Inc*. (RAI) to facilitate the commercialization of their respective e-cigarette and heated tobacco products. Upon BAT's acquisition of RAI in 2017, it gained ownership of the *R. J. Reynolds Vapor Company* (RJRVC), a subsidiary of RAI that had introduced *Vuse* e-cigarettes in 2013. By 2015, *Vuse* had become the leading e-cigarette brand in the US, although it was surpassed by Juul in 2017.[2]

In December 2015, BAT acquired *CHIC*, a Polish e-cigarette company that held approximately 65% of the Polish market, including brands such as *Volish* and *Liqueen*. Although the purchase price was not disclosed, BAT’s 2015 annual report valued the acquisition at £82 million. BAT identified Poland as a strategic "hub" for expanding into other Eastern European markets. Kingsley Wheaton, a BAT executive, described the acquisition of *CHIC* as "strategically significant," noting that it provided BAT with substantial market presence and scale through Europe's largest e-cigarette retail network, along with essential manufacturing and research and development capabilities. By 2019, BAT reported operating

636 retail outlets in Poland, a decrease from 2015, but still significantly more than the approximately 100 outlets it had in the UK and Germany. According to Euromonitor data, Poland was BAT's largest European e-cigarette market by value in 2018, with a market worth over £835 million (US$1 billion), which was four times the value of the UK market, estimated at just over £200 million (US$250 million).[2]

In April 2016, BAT, through its subsidiary *Nicoventures Holdings,* acquired the UK e-cigarette company Ten Motives, which at the time included brands such as *Cirro* and *Aspire*. While the acquisition cost was not disclosed, BAT's 2018 annual report valued the transaction at £56 million. This acquisition, along with other e-cigarette brands, significantly bolstered BAT's market share and retail presence within the UK. By 2019, the Ten Motives website featured a range of BAT products, including *Vype*, alongside some independent brands. Notably, the 'About Us' section of the website included statements on harm reduction but did not explicitly disclose BAT's ownership of the company, although references to *Nicoventures* and BAT could be found in the policy details. By 2020, *Ten Motives* had transitioned to exclusively selling BAT brands.[2]

In July 2017, BAT acquired the e-cigarette company *VIP* from *Must Have Ltd* (MHL) for £11.9 million. The acquisition occurred as MHL faced potential closure due to its inability to satisfy a substantial tax liability. This strategic purchase allowed BAT to further expand its retail network within the UK. Although *VIP* products continued to be sold through their own website, by 2019, the company had been fully integrated into the BAT UK business.[2]

Concurrent with the *VIP* acquisition, BAT also acquired another e-cigarette company owned by MHL, *Vapestick Group*. However, *Vapestick* had ceased operations by November 2018

[2] E-cigarettes: British American Tobacco, *Tobacco Tactics, updated 09 March 2023, accessed 12 August 2024.*

and was formally dissolved in July 2019. From 2020 onwards, *VIP* products were made available through the *Ten Motives* website.[2]

In December 2017, BAT announced its intention to acquire the South African e-cigarette company *Twisp*, which would provide the company with a locally established product and direct access to a significant number of retail outlets in the region. Initially, the South African Competition Commission blocked the sale in 2018, citing anti-competitive concerns. However, BAT received approval to proceed with the purchase in August 2019. According to Kingsley Wheaton, *Twisp*'s retail presence in South Africa was "of strategic importance to our future," as it would enable the development of direct-to-consumer relationships, the acquisition of substantial consumer insights, and the ability to rapidly pilot and test new product lines from BAT's New Category brands. Despite these strategic intentions, sales of e-cigarettes were suspended during the COVID-19 pandemic, leading to financial losses on BAT's investment before *Twisp* was ultimately absorbed into the *Vuse* brand.[2]
In November 2018, BAT acquired *Quantus Beteiligungs-und Beratungsgesellschaft mbH*, recognized as "Germany's leading vapor e-cigarette retail chain," along with its associated website, 'High End Smoke.'[2]

In 2019, BAT, through its subsidiary *Reynolds*, secured a 60% stake in the U.S. e-liquid manufacturer VapeWild for $48 million (approximately £36 million). However, the company was subsequently closed and liquidated due to emerging regulations concerning flavoured e-liquids in the US.[2]

[2] E-cigarettes: British American Tobacco, *Tobacco Tactics, updated 09 March 2023, accessed 12 August 2024.*

Additionally, in 2019, BAT acquired a minority share in *Ayr Ltd*, a UK-based manufacturer and retailer, and appointed a BAT representative to the company's board of directors.[2]

Key Brands and Markets

Between 2017 and 2018, BAT held less than 5% of the global e-cigarette market, while JUUL Labs' market share was rapidly expanding. However, following BAT's acquisition of the U.S. company *Reynolds*, its market share doubled. In 2018, BAT claimed the largest share of the crucial UK market, capturing 41%. Yet, as the market continued to grow and competition intensified – particularly from *JUUL Labs* and other tobacco companies – BAT's share declined in 2019.[2]

By 2019, *Vype* alone accounted for approximately a quarter of BAT's UK market share, with even greater contributions in France. The *Vype ePen3*, in particular, was credited with generating significant revenues in Western Europe. However, *Vype*'s exact share in the expanding Polish market remained uncertain.[2]

According to Jack Bowles, BAT CEO, e-cigarettes were more pivotal for BAT in the U.S. market than its heated tobacco products. In 2019, BAT reported that *Vuse* held a 14% share of the U.S. market, with *Vuse Alto* (alongside the relaunched *Vibe*) driving growth and narrowing the gap with *JUUL*. However, Ricardo Oberlander, President and CEO of RAI, acknowledged that in the U.S., the vapor category remained relatively small compared to the broader tobacco market and had minimal impact on cigarette volumes.

In 2020, BAT indicated that its key markets – the U.S., Canada, Germany, the UK, and France – collectively represented over 75% of global industry vapor revenue. BAT claimed that *Vuse/Vype* held the top position by value share in four out of these five markets. However, by this time, the company was also in the process of reducing its workforce, consolidating its product lines, and striving to reassure investors of the profitability of its new strategy.[2]

Lobbying on E-cigarettes

In the US, BAT and RAI allocated $2.25 million to lobbying efforts in 2017, increasing this expenditure to over $2.6 million in 2018. While the specific proportion dedicated to e-cigarette lobbying is not discernible, BAT's report to the FDA in July 2019 identified four legislative bills directly related to e-cigarettes or youth usage. Between 2017 and 2019, BAT engaged multiple U.S. lobbying firms, including *Ballard Partners, BGR Group*, and *Guidepost Strategies*. In 2018, BAT's lobbying efforts in Western Australia to overturn a ban on e-cigarettes were unsuccessful. Notably, in Australia, nicotine is classified as a poison, necessitating a specific permit for sale. In response to federal-level lobbying by tobacco companies and their affiliates, the Australian government agreed to commission an independent study on e-cigarettes.[2]

In November 2022, coinciding with the government's initiation of a consultation on regulatory reforms, BAT established a front group called 'Responsible Vaping Australia' to advocate for the "sensible regulation of vaping products." In early 2023, The Guardian Australia reported that the group's Facebook page initially did not disclose BAT's involvement and described itself misleadingly as an 'education research center,' later amending this to 'health/medical/pharmacy.' The group's advertisements on Facebook also failed to disclose BAT funding and directed users to a petition encouraging submissions to the government consultation, exemplifying astroturfing – a tactic involving the creation of a fake grassroots campaign. Additionally, industry allies, including the BAT-funded World Vapers Alliance, submitted responses to the consultation.[2]

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[2] *E-cigarettes: British American Tobacco, Tobacco Tactics, updated 09 March 2023, accessed 12 August 2024.*

BAT is a member of the UK Vaping Industry Association (UKVIA), which has lobbied on behalf of tobacco and other companies in the UK. This organization has strong ties to the All-Party Parliamentary Group (APPG) for Vaping (formerly 'for E-Cigarettes'), a group that has provided a lobbying platform for BAT within the UK Parliament. BAT was also invited to present to the UK House of Commons Science and Technology Select Committee, which in August 2018 submitted a "controversial" report on e-cigarettes to the government.[2]

Furthermore, BAT has been affiliated with Vape Business Ireland (VBI), initially under the names *P J Carroll*, then *VIP*, and later *Vuse* (VBI no longer lists its members on its website). Both UKVIA and VBI were signatories to a 2018 document submitted to the World Health Organization (WHO), advocating for the deregulation of e-cigarettes and other electronic nicotine delivery systems (ENDS). In September 2019, BAT, through its subsidiary Imperial Tobacco Canada, played a role in establishing a similar trade association in Canada, the Canadian Vaping Trade Association (VITA). Founding members of this association included *JUUL Labs Canada, Japan Tobacco International* (JTI), and two independent e-cigarette companies, each committing to contribute $100,000 annually for three years. VITA claims to represent and support the Canadian vaping industry in advocating for harm reduction, youth prevention, evidence-based regulations, and best-in-class quality and safety standards. However, its primary objective appears to be lobbying against proposed legislation.[2]

3.3.2 Imperial Brands

Imperial Brands (formerly *Imperial Tobacco*) established a subsidiary, *Fontem Ventures*, in 2012 to develop and market its electronic nicotine delivery systems, which it began selling in 2014. Initially, Imperial targeted the US, the UK, France, and Italy as its primary markets. In

2018, the company started expanding into several new markets with its flagship e-cigarette brand, *blu*. By 2021, Imperial was concentrating its efforts on *blu'*s most profitable markets, namely the US, the UK, and France.[3]

Acquisitions and Alliances

In August 2013, Imperial acquired Hon Lik's e-cigarette company, *Dragonite*, for $75 million, including its Research & Development facility in Beijing. Imperial's initial e-cigarette launch in the UK, *Puritane*, in 2014, was the product of its collaboration with Hon Lik. Initially available in Boots pharmacies, *Puritane* was submitted for licensing as a medical device in the UK but was eventually discontinued in favour of Imperial's flagship e-cigarette brand, *blu*. Imperial acquired the *blu* brand following US tobacco company RAI's acquisition of *Lorillard* in July 2014. Amid concerns that this merger would grant RAI an unfair competitive advantage in the US nicotine market, RAI divested *blu*, along with cigarette brands *Kool, Salem*, and *Winston*, and a manufacturing plant, to Imperial for $7.1 billion.[3]
In June 2017, *Imperial* acquired the Austrian e-cigarette company *Von Erl* for GB£26.7 million (equivalent to approximately US$34.4 million), a transaction that encompassed *Von Erl'*s U.S. subsidiaries.[3]
Subsequently, the *My VonErl* e-cigarette underwent a rebranding in 2018 and was reintroduced as *myblu*. Blu emerged as the premier brand under *Imperial*'s banner in 2018, marking a pivotal and transformative period for the company.[3]

Furthermore, in March 2018, Imperial obtained a stake in a U.S.-based e-liquid enterprise. Market analysis conducted by Euromonitor International revealed that *Cosmic Fog* distributed

[3] *E-cigarettes: Imperial Brands, Tobacco Tactics, updated 02 March 2023, accessed 12 August 2024.*

its merchandise in 60 nations, with a presence in 5,000 e-cigarette retailers across the US. The extent of the acquired share was not disclosed by *Imperial* at that time.[3]

In March 2014, *Imperial* initiated legal actions through *Fontem Ventures* concerning patent matters in California against nine American e-cigarette competitors, including *Lorillard's Blu* (now under *Imperial*'s ownership), *NJOY*, and *Logic* (acquired by JTI in July 2015). The lawsuits were based on claims of patent infringement, citing the violation of four intellectual property patents obtained as part of the *Dragonite* acquisition. The majority of these legal disputes were resolved through out-of-court settlements between 2015 and 2016.[3]

In 2016, *Fontem Ventures* filed a lawsuit against *Nu Mark*, a subsidiary of *Altria*, regarding the *MarkTen* and *GreenSmoke* e-cigarette products. This legal dispute was resolved through an out-of-court settlement in 2017. Additionally, in October 2018, *Fontem Ventures* reached settlements for four patent infringement lawsuits that it had initiated against BAT.[3]

Imperial's initial e-cigarette brand, *Puritane*, was first promoted as a healthcare-related product. An agreement was reached with Boots pharmacies to distribute the *Puritane* brand across their outlets in the UK. Imperial, represented by *Fontem Ventures,* applied to the UK Medicines and Healthcare products Regulatory Agency (MHRA) in 2014 to seek licensure for *Puritane* as a medical device.[3]

This application aimed to enable the company to market the product with claims of reduced risk.

In April 2017, in response to a Freedom of Information request by the University of Bath's Tobacco Control Research Group, the MHRA clarified that no licenses had been granted for a

[3] E-cigarettes: Imperial Brands, *Tobacco Tactics, updated 02 March 2023, accessed 12 August 2024.*

product named *'Puritane'* or held by *Fontem Ventures*. This suggests that *Fontem Ventures'* application for *Puritane* in 2014 was either unsuccessful or had lapsed.[3]

Subsequently, a second e-cigarette named *JAI* was introduced in France and Italy in March 2015. In contrast to *Puritane*, *JAI* was positioned by *Imperial* as a lifestyle product and was promoted through tobacconist channels. *Aspect Consulting*, a public relations firm, facilitated the launch of JAI in France using a mix of online, traditional media, and trade communication methods. Similar to *Puritane*, *JAI* was eventually discontinued.[3]

Since 2016, Imperial's strategic marketing focus has been on *blu*, promoting it as a lifestyle-oriented product.[3]

Flavour is a significant product innovation tool in the e-cigarettes sales growth. Hence, *Imperial*'s product line in 2021 included a diverse range of flavoured e-liquids, such as *Peach Passion, Vanilla Creme, Mint Chocolate, Tropic Tonic, Berry Swirl*, and *Caramel Café*. Like other e-cigarette manufacturers, Imperial has faced criticism for offering flavours that may appeal to minors. Empirical research suggests that fruit and menthol-flavoured e-cigarettes have a greater appeal to young people compared to tobacco-flavoured products. In accordance with its corporate policy, *Imperial* (*Fontem*) does not market e-cigarettes with specific flavours, but it does offer fruit and menthol-flavoured products.[3]

Furthermore, the nicotine concentration of *blu* e-liquid products varies across different countries, subject to specific national regulations. Within the European Union, the maximum permissible nicotine content in e-cigarettes is 20 milligrams per millilitre (20%). According to the UK *Blu* website, *Imperial* offers e-liquids with nicotine concentrations of 9 or 18 mg/ml.[3]

In July 2018, Imperial introduced a line of 'Intense' tobacco and menthol-flavoured e-liquid

[3] *E-cigarettes: Imperial Brands, Tobacco Tactics, updated 02 March 2023, accessed 12 August 2024.*

capsules compatible with *myblu* devices. These e-liquids utilized nicotine salts, a formulation that enhances nicotine absorption and allows for higher nicotine concentrations. All *Intense* capsules offered a nicotine content of 18 milligrams.[3]

Concurrently, *Imperial* launched another e-liquid series, 'Salt of the Earth,' designed for refillable devices in the US market. While initially available in 24 and 48 mg/ml strengths from independent online retailers, these products were subsequently discontinued from the official *blu* US website in April 2021.[3]

Due to the prohibition of nicotine-containing liquids in Japan, *Imperial* introduced a nicotine-free version of *myblu* in June 2018. This adaptation allowed the company to capture a significant market share, reaching 90% of the Japanese e-cigarette market. However, *Imperial* discontinued this product in 2022 due to its lack of profitability.[3]

Key Markets

Imperial's e-cigarette business initially focused on four primary markets: the US, the UK, France, and Italy, operating within these regions between 2014 and 2017. As of 2016, *Imperial* indicated that *blu* had secured the position of the second-largest e-cigarette brand in both the US and UK.[3]

Imperial expanded its e-cigarette operations to Russia, Bulgaria, and Canada in 2018, followed by Spain in 2019. By November 2019, the company reported that *myblu* had a presence in 16 markets, although specific country details were not disclosed.[3]

In February 2021, *Imperial*'s newly appointed CEO, Stefan Bomhard, unveiled a revised five-year strategic plan. This plan encompassed a renewed focus for *blu*, concentrating efforts on

[3] E-cigarettes: Imperial Brands, *Tobacco Tactics, updated 02 March 2023, accessed 12 August 2024.*

key markets such as the US, the UK, and France, while simultaneously withdrawing from less profitable regions. Imperial executed this strategy by exiting the Canadian market in 2020 and subsequently withdrawing from Russia and Japan in 2021.[3]

In 2022, *Imperial* announced that it was conducting trials for a revamped marketing approach aimed at introducing *blu* into new geographical areas.[3]

3.3.3 Japan Tobacco International

Japan Tobacco International (JTI) entered the Electronic Nicotine Deliver System (ENDS) market in 2011 through a minority acquisition in the US-based company *Ploom Inc.*, which has since rebranded as *JUUL Labs*. In subsequent years, JTI expanded its presence in the e-cigarette sector by acquiring the UK-based company *Zandera* in 2014 and the U.S. company *Logic* in 2015. Since 2016, JTI has concentrated its efforts on marketing the Logic e-cigarette brand, which, as of September 2019, was available in 19 countries. In addition to e-cigarettes, JTI has diversified its portfolio to include heated tobacco products (HTPs), snus, and nicotine pouches. The company categorizes its newer nicotine and tobacco products as "next generation products" (NGPs), although this terminology has evolved over time. Presently, JTI refers to its e-cigarettes as "Reduced Risk Products" (RRP), sometimes with the qualifier "potentially," as part of its strategic initiative, "Building a Brighter Future." Despite these developments, conventional tobacco products, such as cigarettes, continue to play a central role in JTI's business operations.[4] Similar to other companies in the industry, JTI frequently introduces new e-cigarette flavours, with names inspired by fruits, sweets, desserts, coffee, and tobacco.[4]

[4] E-cigarettes: Japan Tobacco International, *Tobacco Tactics, updated 24 February 2023, accessed 12 August 2024.*

Product Innovation

In 2022, JTI's UK website listed 18 flavours for *Logic Compact* capsules, available in various nicotine strengths, and 8 flavours for *Logic Pro*. Notably, the *Logic Compact* device is the only JTI product that utilizes the “Intense” range of capsules, which contain nicotine salts.[4] These salts are produced by dissolving ‘freebase’ nicotine in an acid, making higher doses of nicotine more palatable and enabling the consumption of more concentrated nicotine. Within the European Union, the maximum permissible nicotine concentration is 20mg/ml. While other Logic e-liquids offer a range of nicotine levels (6, 12, and 18mg/ml), all ‘Intense’ capsules are standardized at 18mg/ml. JTI’s UK website describes the *Intense* range as providing a “smoother, satisfying, and enhanced experience,” and positions it as “perfect for experienced vapers.” In certain JTI markets, higher concentrations of 34mg/ml and 58/59 mg/ml are also available.[4]

Key Markets

The sale of e-cigarettes containing nicotine is prohibited in Japan. According to Euromonitor, prior to 2016, the primary markets for JTI’s e-cigarettes were the UK and the US. At that time, JTI held a global e-cigarette market share of just under 3%.

Following the rebranding of *E-Lites* products as *Logic* in 2016, JTI began to expand its e-cigarette sales internationally. In 2018, JTI became the first multinational tobacco company to introduce an e-cigarette in Switzerland after the Swiss courts lifted a ban on such sales. By the end of 2018, JTI was marketing its e-cigarettes in 11 countries, with these products accounting for 75% of the company's trade in newer nicotine products, outpacing its HTPs.

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[4] *E-cigarettes: Japan Tobacco International, Tobacco Tactics, updated 24 February 2023, accessed 12 August 2024.*

Despite this expansion, JTI's global e-cigarette market share remained just below 3% in 2018, during which time the company, like other international tobacco firms, lost market share in the U.S. to *JUUL Labs*.[4]

The *Logic Compact* variant emerged as a central component of JTI's strategy, with plans to expand its distribution to 13 additional countries in 2019, focusing on priority markets. In the same year, JTI launched *Logic Compact* in Ireland, Romania, Russia, Canada, Portugal, and Switzerland. In April 2019, the product was introduced in Kuwait, marking JTI's first entry into the Middle Eastern market. Tobacco Asia cited Roger Hambleton, JTI's brand manager for newer products in the Middle East, who noted a growing demand for Reduced Risk Products (RRPs) in Kuwait and a strong belief among locals in the potential health benefits of vaping. Later that year, in December 2019, JTI launched *Logic Compact* in the United Arab Emirates (UAE). In September 2019, the product was also introduced in New Zealand, where tobacco companies, including BAT and *Imperial Tobacco*, were reportedly intensifying their marketing efforts in anticipation of potential regulatory changes by the New Zealand government.[4]

By the end of 2019, JTI reported that its *Logic* brand was available in over 20 markets. In its 2020 annual report, JTI indicated that five different types of e-cigarettes were being sold across 27 countries. Despite the overall growth of the global e-cigarette market, JTI's market share continued to decline, dropping to 2.2% in 2019 and further to 1.5% in 2021. In response, *Japan Tobacco* announced a shift towards a more selective investment strategy. In 2021, the company stated that it had prioritized its e-cigarette efforts in Ireland, Poland, the

[4] E-cigarettes: Japan Tobacco International, *Tobacco Tactics, updated 24 February 2023, accessed 12 August 2024.*

UK, and the US. However, it remains unclear whether JTI had withdrawn its products from certain other markets.[4]

Advertising Strategy

As advertising restrictions on e-cigarettes have tightened in Europe and other regions, tobacco companies, including JTI, have had to adopt more innovative marketing strategies. JTI, like its competitors, increasingly relies on social media and influencers to promote its products. For example, the launch of the *Logic Compact* in September 2018 featured a collaboration with UK fashion designer Pearl Lowe, who designed an exclusive case for the device. This case was available only as part of an online inclusive starter pack. Lowe participated in a launch event held at "The Vapartment," a pop-up vaping lounge in a London venue known for its associations with art, design, sustainability, and healthy living. The event coincided with the start of London Fashion Week, where the first 50 visitors received a free product in exchange for providing their email addresses and had the opportunity to test the device in what was marketed as "the perfect alternate office environment." The creative agency behind the event noted that the media launch was followed by three days of consumer engagement and sampling, featuring DJs and influencers.[4]

In the UK, JTI's strategy also involved targeting shop owners through specialized retail trade websites and recruiting "Logic Champions" to help maximize sales. Additionally, JTI has engaged in lobbying efforts aimed at limiting regulatory measures concerning its products, particularly in Scotland.[4]

[4] *E-cigarettes: Japan Tobacco International, Tobacco Tactics, updated 24 February 2023, accessed 12 August 2024.*

Lobbying

JTI has actively lobbied for the legalization of e-cigarettes in Australia, despite the existing ban on their commercial sale. In March 2019, JTI submitted a written response to a consultation on the review of tobacco control legislation in Australia. In its submission, JTI advocated for distinct regulations for e-cigarettes and other newer products, offering to provide insights on how tobacco control legislation could be revised to improve public health in Australia, citing Better Regulation principles.[4]

This was not JTI's first engagement with Australian regulators. In 2017, the company had also submitted a response to a prior inquiry, emphasizing the argument of consumer choice. JTI asserted that adults should have the freedom to choose whether to use e-cigarettes, while also stressing that no one should use these products without a clear understanding of the associated risks. JTI has actively lobbied Scottish politicians to promote its e-cigarettes and to oppose regulatory measures. In October 2019, JTI sponsored a fringe event at the Scottish National Party (SNP) conference titled "Where Next for Vaping in Scotland," with several Members of the Scottish Parliament (MSPs) listed as speakers. The session was chaired by John Lee from the Scottish Grocers' Federation (SGF), of which JTI is a member. The SGF, which advocates for industry interests in Scotland, has been involved in lobbying efforts, including an attempt in 2018 to establish a parliamentary group focused on harm reduction. SGF representatives have also participated in meetings with MPs and ministers involved in tobacco control policy.[4]

Numerous documented meetings between JTI and MSPs since November 2018 have been, at least in part, focused on e-cigarettes and other newer products. Additionally, JTI holds a

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[4] E-cigarettes: Japan Tobacco International, *Tobacco Tactics, updated 24 February 2023, accessed 12 August 2024.*

membership and a board position in the UK Vaping Industry Association (UKVIA), which lobbied against e-cigarette regulation during the 8th World Health Organization Framework Convention on Tobacco Control (WHO FCTC) Conference of the Parties in 2018.[4]

3.3.4. Philip Morris International

Philip Morris International (PMI) was the last of the major TTCs to enter the e-cigarette market. The company announced its intention to produce its own e-cigarette in November 2013.[5]

By 2020, PMI's product portfolio included several e-cigarette brands, such as *Nicocigs*, *Solaris*, and *IQOS Mesh*, which was later rebranded as *VEEV*.[5]

PMI consistently categorizes e-cigarettes as part of its portfolio of "reduced risk products (RRPs)," which also includes tobacco-containing products. Prior to 2012, PMI referred to these newer nicotine and tobacco products collectively as "next generation products."

In a report to shareholders in April 2019, PMI disclosed that it had invested US$6 billion in these types of products over the previous decade. This investment encompassed research, product and commercial development, production capacity, scientific validation, and studies on adult smoker perceptions. In 2018, these expenditures accounted for 92% of PMI's total research and development budget. By the end of that year, PMI held 4,600 patents related to RRPs worldwide, with over 6,000 additional patents pending.

The majority of PMI's research and development efforts had been focused on heated tobacco products, which the company had "deliberately prioritized." However, in 2019, PMI indicated

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[4] *E-cigarettes: Japan Tobacco International, Tobacco Tactics, updated 24 February 2023, accessed 12 August 2024.*

[5] *E-cigarettes: Philip Morris International, Tobacco Tactics, updated 28 July 2023, accessed 12 August 2024.*

that it had also made significant investments in e-vapor products and was prepared to introduce them on a large scale.[5]

In December 2013, PMI entered into a comprehensive agreement with *Altria*, encompassing a series of licensing, supply, and cooperation arrangements. Under this agreement, PMI secured the exclusive rights to sell *Altria*'s e-cigarettes outside the United States, while Altria obtained the exclusive rights to market PMI's e-cigarettes within the U.S. Additionally, the two companies agreed to collaborate on securing regulatory approval for these products. In July 2015, PMI and *Altria* announced plans to expand their joint efforts in researching and developing new e-cigarettes. They also reiterated their commitment to continue collaborating on regulatory engagement and approval processes.[5]
Until 2020, PMI primarily focused its e-cigarette marketing efforts on the UK and Irish markets. In June 2014, PMI acquired the independent UK e-cigarette company *Nicocigs*, which at the time held an estimated 27% share of the UK's £275 million (US$350 million) e-cigarette market. PMI also introduced its brands *Nicolites* and *Vivid* in the UK. In 2016, PMI rebranded *Nicolites* as *Nicocig*. However, by 2019, these products were no longer sold directly, with customers being redirected from the *Vivid Vapours* website to an independent retailer, alongside a link to *IQOS Mesh*. Following the acquisition of *Nicocigs* in 2014, PMI claimed to have the largest share of the UK e-cigarette market. Despite the market's subsequent expansion, PMI's e-cigarette brands experienced a decline in market share each year. According to Euromonitor International, *Nicocig*'s market share decreased from 7.5% in 2014 to 0.7% in 2019, while Vivid Vapor's share fell from 4.7% to 0.3%. Consequently, PMI's total market share in the UK dropped from 12.2% in 2014 to 1.2% in 2019. During the

[5] *E-cigarettes: Philip Morris International, Tobacco Tactics, updated 28 July 2023, accessed 12 August 2024.*

same period, the UK e-cigarette market grew significantly in value, increasing from nearly £440 million to over £2.1 billion, a rise of nearly 500%.
In September 2014, *Nicocigs* registered trademarks for a refillable e-cigarette called *VYGO*, although this product never appeared on the market. While the UK e-cigarette market remained fragmented, with numerous independent companies, by 2017, the market leaders were BAT brands.[5]

According to financial statements filed by *Nicocig* at UK Companies House in 2018, the company reported a loss of over £4.3 million in 2016 and £8.8 million in 2017. The accounts also noted over £14.9 million in "amounts owed to group undertakings" and affirmed that *Nicocigs* remained a going concern based on the continued support of its parent company, Philip Morris Holdings B.V. In its 2018 financial report, the company recorded a further loss of nearly £2 million, with revenue declining by half to under £4 million from over £8.5 million the previous year.[5]

In May 2018, PMI announced a contract with *Primeline Group*, granting the Irish marketing company distribution and marketing rights for *Nicocig* and *Vivid* in Ireland, effective from December 2018.[5]

The *Vivid* website was shut down in 2019, and its products were discontinued. According to Companies House records, *Nicocigs* ceased supplying products to the UK market in mid-2020. After incurring further losses, the company was scheduled for closure in 2021, with net debts amounting to more than £14 million. The company's 2020 accounts attributed its financial difficulties to a "challenging" business environment and increased competition as the

[5] *E-cigarettes: Philip Morris International, Tobacco Tactics, updated 28 July 2023, accessed 12 August 2024.*

market became saturated with a large number of suppliers. However, the report did not mention that one of the competitors was its parent company, PMI, which had introduced new products such as *Mesh* and *VEEV*.[5]

In 2015, PMI began selling *Altria*'s *MarkTen* e-cigarette, rebranded as Solaris, in Spain (March) and Israel (December). Altria discontinued *MarkTen* in the United States in 2018. In Spain, *Solaris*'s market share declined from 1.7% in 2016 to 0.7% in 2019, and it did not appear in Euromonitor's market data for Israel. By January 2020, Solaris was no longer featured on the 'leading brands' page of PMI's website, indicating that PMI had already shifted its focus to its own e-cigarette, *Mesh*.[5]

By 2016, PMI had developed an e-cigarette named *IQOS Mesh*. Initially, the IQOS brand was exclusively associated with PMI's heated tobacco products, which created some confusion with the introduction of Mesh. Prior to its official launch, PMI hosted an event for selected "vape insiders" in Neuchatel, Switzerland. IQOS Mesh was first introduced in the UK in 2016, although it was not widely available at that time. Following a test marketing phase in London, the product became more broadly available in July 2018, being sold in UK supermarkets such as Sainsbury's, petrol station forecourts, and IQOS stores.[5]

The *IQOS Mesh* e-cigarette was designed to use pre-sealed nicotine cartridges branded as *VEEV*, which were available in three nicotine levels and a variety of "gourmet" flavours, including "Tobacco Harmony," "Summer Garden," and "Passion Fruit Zest" in 2019. The *Mesh* device was marketed on the *IQOS* website alongside the company's heated tobacco products.[5]

[5] [5] *E-cigarettes: Philip Morris International, Tobacco Tactics, updated 28 July 2023, accessed 12 August 2024.*

Publicly available company documents from 2018 and early 2019 made no specific mention of IQOS Mesh sales, though initial results were described as "promising." According to Euromonitor, PMI launched *IQOS Mesh* to capitalize on the rapidly growing non-cig-a-like closed system category in the UK. Despite this, *Mesh* achieved only a 0.2% market share in the UK in 2018 and 2019, and Euromonitor noted that it was "virtually non-existent" in the global e-vapor market.[5]

In May 2019, former PMI CEO André Calantzopoulos announced plans to expand the international sale of IQOS e-cigarettes in 2020, leveraging the success of *IQOS* heated tobacco products. However, in February 2020, while presenting PMI's 2019 financial results, Calantzopoulos attributed the slow rollout of the *IQOS Mesh* to "consumer confusion around e-vapor in the latter part of 2019." He confirmed that a new version, "IQOS MESH 2.0," would be launched in 2020. In a subsequent presentation, he discussed plans for an "accelerated launch in Quarter 3 of 2020," under the brand name *IQOS VEEV*, with "Mesh" referring specifically to the device's technology. Calantzopoulos described *VEEV* as a product "worthy of the *IQOS* brand" and suitable for "e-vapor users, adult smokers considering the e-vapor category, and dual users of e-vapor and heated tobacco products."[5]

By April 2020, PMI had withdrawn the *IQOS Mesh* from sale in the UK, although *VEEV* liquid capsules remained available, and the Mesh device continued to be listed on PMI's website. In remarks to investors in February 2020, Calantzopoulos emphasized that PMI's "key objective is to achieve sustainable e-vapor category leadership over time." Despite these ambitions, Euromonitor data indicated that PMI's share of the global e-cigarette market had declined to 0.2% in 2019, continuing a downward trend from the 1.3% share held in 2014.

[5] *E-cigarettes: Philip Morris International, Tobacco Tactics, updated 28 July 2023, accessed 12 August 2024.*

In April 2020, amid the COVID-19 pandemic, PMI acknowledged potential delays in the rollout of *IQOS Mesh/VEEV* and licensed KT&G products. During this period, the *VEEV* e-liquid page on the UK IQOS website included a promotional pop-up for *IQOS* menthol tobacco *HEETS* sticks. Following its launch in New Zealand in September 2020, PMI announced the commencement of commercialization for *IQOS VEEV*, describing it as their new e-vapor product. However, it remained unclear whether *IQOS VEEV* was a new product, an enhanced version, or simply a rebranded *IQOS Mesh*, as PMI's website in November 2020 still referenced Mesh devices alongside *VEEV* liquids.[5]

PMI indicated plans for additional product launches in 2020 and 2021, leveraging the existing commercial infrastructure of *IQOS* for efficient, large-scale deployment. The company also noted that it would be testing age verification technology in select markets. According to its 2020 annual report, PMI launched *VEEV* in the Czech Republic in December and confirmed the discontinuation of its older devices utilizing a coil-and-wick system in favour of the newer Mesh technology. By the end of 2021, PMI reported that *VEEV*, now described as an "improved version of *IQOS Mesh*," was also available in Canada, Corsica, Croatia, Finland, Italy, and Ukraine.[5]

In 2018, PMI announced the development of a new nicotine salt e-cigarette called *STEEM*, reportedly "inspired by technology acquired from Duke University" in 2011. This e-cigarette utilizes a nicotine salt formed by dissolving freebase nicotine in acid, allowing for the consumption of higher doses of more concentrated nicotine. However, according to Euromonitor, *STEEM* was "virtually non-existent" in the international market in 2018.

In a February 2020 presentation to analysts, PMI included a map of the "e-vapour landscape," highlighting varying nicotine concentration limits in the ten largest e-cigarette markets, such

[5] *E-cigarettes: Philip Morris International, Tobacco Tactics, updated 28 July 2023, accessed 12 August 2024.*

as the absence of limits in Canada, Russia, and Ukraine. Despite this, STEEM was not mentioned in the presentation or in PMI's 2020 and 2021 annual reports. By 2022, all references to *STEEM* had been removed from PMI’s website.[5]

In June 2022, PMI signed an agreement with *Kaival* for the manufacturing, distribution, and marketing of *Bidi Stick* and future “disposable” products outside the United States. *VEEBA*, a new product under this arrangement, was launched in Canada in July 2022 and was reported to be the lowest-priced disposable e-cigarette available on the market at that time.[5]

Beginning in 2014, it became evident that PMI viewed its future innovation strategy as centred on HTPs rather than e-cigarettes. PMI asserts that HTP devices heat tobacco to a temperature sufficient to release flavour and nicotine without igniting the tobacco and producing smoke. This method presumably delivers a stronger and more immediate nicotine hit, akin to that of conventional cigarettes. At the time, Calantzopoulos noted that “the current generation of e-cigarettes generally has a much slower delivery profile than conventional cigarettes, which, combined with a less robust taste, results in limited user satisfaction and reduced adoption rates.”[5]

In January 2014, PMI announced a planned investment of up to EUR 500 million (USD 680 million) in establishing its first manufacturing facility for “potentially reduced-risk” tobacco products in Europe, along with an associated pilot plant in Italy. Most of this new capacity appeared to be allocated for the production of HTPs.[5]

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[5] *E-cigarettes: Philip Morris International, Tobacco Tactics, updated 28 July 2023, accessed 12 August 2024.*

Between 2017 and 2018, PMI joined two European industry associations: the UK Vaping Industry Association (UKVIA), which advocates for e-cigarette regulation in the United Kingdom, and Vape Business Ireland (VBI), which serves a similar role in the Republic of Ireland. Until 2021, *Nicolites* was listed as a member of Vape Business Ireland; however, the listing was subsequently updated to reflect *IQOS* as the member. It is noteworthy that VBI no longer appears to list its members on its website. Both UKVIA and VBI were signatories to a document submitted to the WHO, advocating for the deregulation of e-cigarettes and other ENDs.[5]

3.4 The relevant legal framework

3.4.1 World Health Organisation

The World Health Organization (WHO) has outlined a regulatory framework for ENDS, designed to protect public health while addressing the potential risks associated with these products. This framework aims to ensure that the use of e-cigarettes is effectively regulated, particularly regarding their safety, accessibility, and potential appeal to youth. The core elements of this framework include the following[6]:

Preventing Use by Non-Smokers and Youth

- *Sales Restrictions*: E-cigarettes should not be sold to minors. Governments are encouraged to set a minimum age for purchasing ENDS, typically 18 years or older.
- *Marketing and Advertising Restrictions*: Advertising and promotional activities for e-cigarettes should be restricted or banned, especially those targeting young people.

[5] *E-cigarettes: Philip Morris International, Tobacco Tactics, updated 28 July 2023, accessed 12 August 2024.*
[6] *World Health Organisation, WHO report on the global tobacco epidemic 2021: addressing new and emerging products*

- *Flavour Restrictions*: WHO recommends limiting or banning flavours that are particularly appealing to youth (such as candy or fruit flavours), which can increase the risk of youth initiation into vaping.

<u>*Product Standards and Safety*</u>

- *Nicotine Concentration Limits*: Governments should establish clear regulations regarding the maximum concentration of nicotine in e-cigarettes. This is to ensure that the nicotine levels are not excessively high, which could lead to greater addiction risks.
- *Quality Control and Safety*: All e-cigarette devices and e-liquids should be subject to rigorous product standards, including regulations on the safety of battery mechanisms, packaging, and the quality of ingredients. This includes preventing the inclusion of harmful chemicals and ensuring that the products are manufactured in a manner that minimizes risks such as device malfunctions or e-liquid contamination.
- *Packaging and Labelling*: E-cigarette products should carry health warnings on their packaging, like conventional cigarettes. Labels must accurately disclose the ingredients and include warnings about the addictive nature of nicotine.

<u>*Banning Health Claims without Evidence*</u>

- *Prohibition on Unsubstantiated Health Claims*: Manufacturers should be prohibited from claiming that e-cigarettes are a safer alternative to conventional cigarettes or an effective smoking cessation tool unless there is scientific evidence to support such claims. These claims must be evaluated and approved by relevant regulatory bodies before being made.
- *Regulating as Medicinal Products*: If an e-cigarette product is marketed as a smoking cessation device, it should be regulated as a medicinal product and subject to the same standards for safety, efficacy, and quality as other medical devices.

Preventing Harm to Non-Users

- *Regulations on Vaping in Public Spaces*: vaping should be restricted or banned in enclosed public spaces, public transportation, and other areas where smoking is prohibited.
- *Second-Hand Exposure*: countries should monitor the effects of second-hand exposure to e-vapor and implement policies that protect vulnerable groups from such exposure.

Taxation and Price Regulation

- *Taxation of E-Cigarettes*: WHO recommends that governments consider applying taxes to e-cigarettes and related products like those imposed on conventional tobacco products.
- *Minimizing Economic Incentives for Use*: Governments should avoid offering financial incentives for the production and sale of e-cigarettes.

Monitoring and Research

- *Surveillance of E-Cigarette Use*: WHO calls for continuous monitoring of e-cigarette usage patterns, including prevalence rates among youth, adults, and specific sub-populations such as non-smokers.
- *Research on Health Effects*: governments and public health agencies are encouraged to support independent research into the long-term health effects of e-cigarettes and to examine their potential to aid in smoking cessation, as well as their role in promoting dual use (i.e., using both e-cigarettes and conventional cigarettes).
- *Monitoring Industry Practices*: governments should closely monitor the marketing, production, and lobbying practices of the e-cigarette industry to ensure compliance with public health regulations and to prevent industry interference in policymaking.

Prevention of Dual Use and Gateway Effect

- *Addressing Dual Use*: WHO expresses concern that many smokers may use e-cigarettes alongside with traditional cigarettes, potentially prolonging nicotine addiction rather than helping users quit. Regulatory frameworks should ensure that dual use is discouraged and that smokers are informed about the importance of completely switching from combustible tobacco products to reduce harm.
- *Preventing E-Cigarettes as a Gateway to Smoking*: WHO stresses the importance of preventing e-cigarettes from serving as a gateway to conventional smoking, particularly among youth and non-smokers. Regulatory policies should prioritize measures that limit the appeal of e-cigarettes to individuals who have never smoked.

3.4.2 European Union

Tobacco Products Directive (2014/40/EU)

The regulation of e-cigarettes within the European Union is primarily governed by the Tobacco Products Directive (TPD). Enforced from May 2016, the directive is fundamentally aimed at safeguarding public health, with a particular emphasis on reducing smoking prevalence and ensuring that consumers are well-informed about the health risks associated with tobacco and nicotine use.[7] The key provisions of the directive are as follows:

Health Warnings and Packaging Standards

- The directive mandates that tobacco product packaging, including cigarettes and roll-your-own tobacco, feature graphic health warnings that cover 65% of both the front and back of the packaging. These warnings combine text and imagery to highlight the dangers of tobacco consumption.

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[7] Tobacco Products Directive (2014/40/EU)

- The use of misleading descriptors such as "light," "mild," or "low tar" is prohibited, as these terms may mislead consumers into believing that certain products are less harmful than others.

Control of Ingredients and Emissions

- Tobacco product manufacturers are required to submit comprehensive reports on the ingredients and emissions of their products to national authorities and the European Commission. This ensures transparency regarding the chemical content of these products.
- The directive bans certain flavourings that could mask the natural harshness of tobacco, making it more appealing, especially to younger demographics.

Regulation of Electronic Cigarettes

- The directive establishes a regulatory framework for e-cigarettes containing nicotine, ensuring they comply with strict safety and quality standards.
- The nicotine concentration in e-cigarettes is capped at 20 mg/ml, and the tank capacity of refillable devices must not exceed 2 ml.
- E-cigarettes are required to bear health warnings like those found on tobacco products. Marketing claims that suggest health benefits of e-cigarettes are prohibited.
- Manufacturers must submit comprehensive product information to the European Commission, including data on nicotine content, ingredients, and toxicological properties.
- The directive also prohibits cross-border advertising of e-cigarettes within the EU.

Product Traceability and Safety Measures

- To combat the illicit trade of tobacco products, the directive implements a track-and-trace system, which ensures the traceability of products from production through to retail.

- The directive imposes compliance checks on tobacco and e-cigarette products to ensure that they meet safety standards, with provisions for product recalls where necessary.

Prohibition of Certain Products

The sale of tobacco for oral use, such as snus, is prohibited throughout the EU, apart from Sweden, which holds a special exemption.

Reporting Obligations

EU Member States are required to submit periodic reports on the implementation of the directive. These reports assess the directive's impact on public health, smoking rates, and the overall tobacco and e-cigarette market within their respective jurisdictions.

Objectives of the Directive

The aims of the TPD are to:

- Enhance consumer protection by ensuring that tobacco and nicotine products are manufactured and marketed according to stringent health and safety standards.
- Reduce smoking rates, particularly among young people, by regulating the availability and marketing of tobacco and e-cigarette products.
- Provide clear and accurate information about the health risks and chemical composition of tobacco and e-cigarette products.
- Harmonize regulations across EU Member States.

Overall, the directive underscores the EU's commitment to reducing the public health burden associated with tobacco and nicotine use, while responding to the emergence of new nicotine products, through a comprehensive regulatory framework designed to protect consumers and deter smoking.

Commission Delegated Directive (2022/2100/EU)

The Commission Delegated Directive 2022/2100, which came into effect on November 23, 2022, introduced a prohibition on the sale of flavoured heated tobacco products within the EU. Heated tobacco products are classified as a "novel tobacco product" that is heated to produce emissions containing nicotine and other chemicals, which are then inhaled by users. These products may be categorized as smokeless tobacco or tobacco products for smoking, depending on their specific characteristics. This prohibition forms part of the EU's broader Europe's Beating Cancer Plan, which aims to establish a "Tobacco-Free Generation" by 2040, where less than 5% of the EU population will consume tobacco, compared to the current figure of approximately 25%. Under the directive, EU member states are required to transpose this prohibition into national legislation by July 23, 2023, with the provisions taking effect from October 23, 2023. The prohibition is an essential step towards reducing tobacco consumption and improving public health across the region.[8]

3.4.3 North America

In North America, the regulation of electronic cigarettes is primarily managed by federal, state, and provincial authorities, with a focus on ensuring consumer safety, preventing youth access, and controlling the marketing and sale of these products.[9] The most important laws and regulations in the United States and Canada are outlined as follows:

[8] *Commission Delegated Directive (2022/2100/EU)*

[9] *FDA Regulation under the Family Smoking Prevention and Tobacco Control Act (2009)*

United States

Food and Drug Administration (FDA) Regulation under the Family Smoking Prevention and Tobacco Control Act (2009)

The FDA is the primary federal agency responsible for the regulation of e-cigarettes in the U.S. under the Family Smoking Prevention and Tobacco Control Act. In 2016, the FDA extended its regulatory authority to cover e-cigarettes through its Deeming Rule, which introduced key provisions such as:

- *Premarket Authorization*: E-cigarette manufacturers must submit products for premarket review by the FDA to demonstrate that they are appropriate for the protection of public health before being sold. This process involves the submission of Premarket Tobacco Product Applications (PMTAs).
- *Ingredient Disclosure*: Manufacturers are required to disclose all ingredients used in e-liquids, including nicotine content, to the FDA.
- *Nicotine Warnings*: All e-cigarette packaging and advertisements must carry a nicotine addiction warning, typically phrased as "This product contains nicotine. Nicotine is an addictive chemical."
- *Youth Access Restrictions*: The minimum age for purchasing e-cigarettes was raised to 21 as part of the Tobacco 21 legislation passed in 2019. Retailers must check photo identification for any purchaser under 27.
- *Ban on flavoured products*: in early 2020, the FDA issued guidance banning the sale of flavoured cartridge-based e-cigarettes, except for tobacco and menthol flavours, in an effort to reduce youth usage. However, open systems, where users can refill tanks, remain unaffected.

The Federal Trade Commission (FTC) works in conjunction with the FDA to regulate the advertising and promotion of e-cigarettes. The FTC ensures that e-cigarette companies do not make false or misleading claims about the safety, health benefits, or risks associated with their products. This includes monitoring marketing practices that may target minors.

3.4.4 Asia

The regulation of e-cigarettes across Asia varies widely between countries, reflecting differing public health priorities, cultural attitudes towards smoking, and stages of regulatory development. While some nations have embraced e-cigarettes as a potential harm reduction tool, others have taken stringent measures to limit or ban their use due to concerns about health risks and youth addiction.

China

Tobacco Monopoly and Regulation of E-cigarettes

China, the largest producer of e-cigarettes, has recently moved towards more stringent regulation of their sale and use. In 2021, the Chinese government amended the Tobacco Monopoly Law to bring e-cigarettes under the same regulatory framework as traditional tobacco products. This marked a significant shift in policy, with the State Tobacco Monopoly Administration (STMA) assuming control over the industry.[10] Key aspects include:

- *Production licenses*: e-cigarette manufacturers must obtain a production license from the government. These licenses ensure that products meet national quality and safety standards.
- *Product standards and testing*: in 2022, China issued national standards for e-cigarettes, regulating aspects like nicotine content, ingredients, and vapor production. Products must undergo mandatory testing to ensure compliance.

[10] *Tobacco Control Laws, Administration Announcement of the State Tobacco Monopoly, 2022*

- *Flavoured e-cigarettes*: as of October 2022, flavoured e-cigarettes, except for tobacco-flavoured products, have been banned to reduce their appeal to youth. This aligns with global trends aimed at curbing youth vaping.
- *Sales and advertising restrictions*: e-cigarettes can only be sold through licensed tobacco retailers, and their advertising is strictly regulated to prevent youth targeting. Online sales of e-cigarettes are also prohibited.

Harm Reduction Policy

Despite its regulatory control, China views e-cigarettes as a potential tool for harm reduction among adult smokers.

The government's regulation seeks to balance this potential with concerns about addiction, particularly among young people.

Japan

Japan has taken a unique approach to regulating e-cigarettes, differentiating between nicotine-containing e-cigarettes and non-nicotine vapor products:

- *Nicotine-containing e-cigarettes*: the sale and importation of e-cigarettes containing nicotine are banned unless they are registered as a medicinal product. This registration requires proof of safety and efficacy, and as of now, no e-cigarette has been approved under this framework.
- *Non-nicotine e-cigarettes*: e-cigarettes that do not contain nicotine are legal and widely available, often marketed as alternative vapor products. However, their health claims and marketing are regulated to avoid misleading consumers.

HTP Products

Japan has seen a significant shift towards HTPs, such as *IQOS*, which are not classified as e-cigarettes. HTPs, which heat tobacco to release nicotine without combustion, are allowed and heavily regulated. These products dominate Japan's market due to the ban on nicotine-containing e-cigarettes.

3.5 The Global Market

According to data from Euromonitor International, the global e-cigarette market experienced significant growth between 2014 and 2018, with its value increasing from US$6.8 billion to over US$15.5 billion. By 2021, the market's value had further expanded to approximately US$22.8 billion. The largest markets during this period were the United States and Western Europe. In the United States, market value rose from US$2.6 billion in 2014 to over US$9.6 billion in 2019, followed by a notable decline in 2020, reaching around US$7.8 billion by 2021. Similarly, the Western European market grew from US$2.3 billion to US$6.5 billion by 2021, with the United Kingdom emerging as the region's largest market, valued at over £2.6 billion in 2021. The market value in the Asia-Pacific region, a strategic focus for tobacco companies, nearly doubled from US$1.4 billion between 2014 and 2018. Following rapid expansion to US$2.2 billion in 2019, it doubled once again, reaching US$4.4 billion by 2021, making it the fastest-growing regional market in terms of value. In contrast, market growth in Eastern Europe and the Middle East was slower. The significantly smaller Latin American market, though modest in size, increased to US$120 million by 2021, nearly doubling within a two-year period.[11]

The size of the e-cigarette market is evidently influenced by national regulations governing the sale of these products. Nevertheless, the presence of laws restricting or prohibiting e-

[11] *E-cigarettes – Global Markets, Tobacco Tactics, updated 02 February 2023, accessed 27 August 2024.*

cigarette sales does not always prevent tobacco company products from being available for purchase in a given country.[10]

According to Euromonitor International, BAT's share of the global e-cigarette market by value reached approximately 17.5%, a significant increase from 3.5% in 2016, prior to its acquisition of RAI. Meanwhile, JTI and PMI experienced declines in market share since 2014, and *Imperial's* share began decreasing after 2016. PMI holds the smallest overall share among the major transnational companies, at just 0.2%.[11]

Between 2015 and 2019, tobacco companies lost a significant portion of the e-cigarette market to the emerging competitor *JUUL Labs,* whose global market share surged to nearly 28% by 2019. In the United States, *JUUL*'s growth was even more pronounced, as it captured market share from both independent e-cigarette companies and traditional tobacco firms. By 2019, *JUUL* controlled over 50% of the U.S. market. It also gained more than 15% of the market in Ukraine, though it struggled to expand in Western Europe, eventually beginning to withdraw from those markets in 2020. Confronted with increasing regulatory challenges, particularly in the U.S., *JUUL*'s market share began to decline in 2020.[10]

Independent (non-transnational tobacco company) e-cigarette manufacturers have consistently held the majority share of the global market. However, their share declined from over 80% in 2014 to just above 56% by 2019. This trend began to reverse in 2021, likely as a result of *JUUL*'s withdrawal from several markets. Since 2017, the Chinese company *RELX Technology* has experienced rapid growth, nearly doubling its market share annually to reach 9% by 2021, positioning it as the third largest market player after BAT and *JUUL*.[11]

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[11] *E-cigarettes – Global Markets, Tobacco Tactics, updated 02 February 2023, accessed 27 August 2024.*

In 2021, the company with the fourth largest share of the global market, following *RELX*, was *EVO* Brands, which held a 1.7% share. *EVO* is the manufacturer of disposable e-cigarettes under the *Puff Bar* brand.[11]

JTI has been offering disposable e-cigarettes in the U.S. market since its acquisition of the Logic brand in 2015. However, it was not until 2022 that BAT and PMI introduced their own new disposable products, *Vuse Go* and *Veeba*, launched within two months of each other.

[11] *E-cigarettes – Global Markets, Tobacco Tactics, updated 02 February 2023, accessed 27 August 2024.*

CHAPTER 4. Empirical Analysis

This chapter outlines the data sources, methodologies, and analytical techniques employed in this research. It provides a foundation for understanding how the study was conducted, providing transparency about the processes involved in data collection, preparation, and analysis. First, the types and sources of data used in the study are described, including any relevant secondary data. Then, the methods applied for data processing and analysis are detailed, explaining the rationale behind the chosen methodologies.

4.1. Data Collection

In this section, the process of data collection is explained, highlighting the various sources employed for gathering relevant information. The research primarily relied on several key resources, including the official websites of companies, which provided direct insights into product offerings, corporate history, and updates. Additionally, online newspaper articles were consulted to gather industry news, trends, and significant developments. One of the major sources used was *Sigmagazine*[12], an industry-specific online journal, which offered specialized content on electronic cigarettes and vaping products. The *Tobacco Tactics*[13] website, managed by the University of Bath, was another valuable resource for comprehensive information on tobacco and nicotine-related products. Finally, blogs dedicated to electronic cigarettes were explored to obtain consumer perspectives, product reviews, and informal discussions about emerging trends in the vaping market. Blogs were also useful for researching and gathering additional information on the earliest electronic cigarettes and the companies that produced them.

[12] *Sigmagazine*, accessed 13 October 2024
[13] *Tobacco Tactics*, accessed 13 October 2024

The data gathered was included in a detailed dataset of 100 companies, which comprises each company's name, year of foundation, and key milestones related to their involvement in various generations of electronic cigarettes — namely, the first, second, third, and fourth generation. Additionally, this dataset captures the years in which these companies entered or exited the markets for heat-not-burn tobacco products and modern disposable e-cigarettes. The dataset also specifies if the companies are independent or part of a larger group, or if they are also e-liquid producers.

The start of each new generation, as well as the first introduction of heat-non-burn and modern disposable e-cigarette, coincided with the first introduction of its first product. More specifically:

- *Hon Lik's* first commercialisation of its so called "*cigalike*" in 2003 instituted the first generation of electronic cigarettes and the industry itself. The product was sold by *Dragonite International Limited*;
- In 2009, *Joyetech* started producing the *vape pen* eGo, starting the second generation;
- The American company *ProVape* invented its game-changing product *Provari* in 2010, starting the third generation of electronic cigarettes, the so-called *mod box*;
- Also in 2010, *Japan Tobacco International* introduced the first HTP device;
- In 2015 *PaxLabs* commercialised the *JUUL* device, starting the fourth generation of electronic cigarettes, also called *pod mods*. *JUUL* later on became an independent company, in 2017;
- *Puff Bar* is considered to have introduced the first modern disposable e-cigarette, its *Puff* device, in 2018.

For companies where more precise information regarding the year of exit from the first and second generations was not available, 2018 has been used as an approximation. This decision was based on the fact that 2018 marked a significant turning point in the industry, with the emergence of new products and a shift in consumer preferences.

For each generation and market, two different dummy variables were created, the first one determining if a company entered a specific market (0 if it did not enter, 1 if it did), and the second one determining if a company exited a specific market (0 if it did not exit, 1 if it did). The following additional variables were generated: the first one specifies if a company is part of a larger group (1) or independent (0), the second indicates if a company also produces e-liquids (1) or not (0), while the third dummy captures whether a company was already active in the tobacco industry (1) or not (0).

This collection of data provides a chronological and quantitative perspective on the evolution of these companies within the broader context of the vaping industry.

4.2. Descriptive statistics

The data were employed to analyse company activity across the six key markets as defined above: first generation, second generation, third generation, and fourth generation e-cigarettes, HTP devices, and disposable e-cigarettes. Graphs and tables were created to illustrate the market dynamics within the industry. These visualizations included the number of companies entering versus exiting the industry, showing the evolution of companies over time. Additionally, charts were developed to highlight market entry patterns for specific products, such as ENDS, HTPs and disposable e-cigarettes.

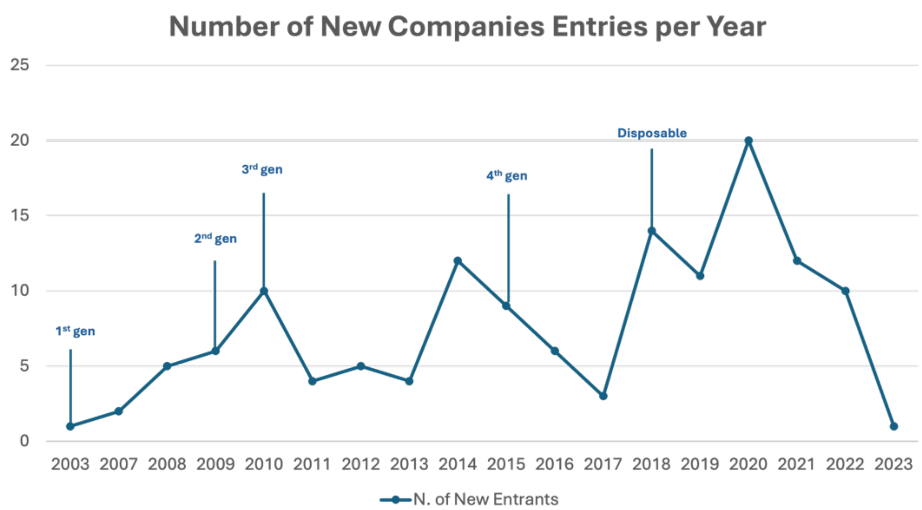
A table was also constructed to show the average number of years it took companies to enter each specific market. Furthermore, another table was designed to track the number of incumbents across different years, providing a clear picture of how company presence has shifted in the industry over time.

Additionally, another table was developed to analyse the distribution of companies across multiple markets. This table details how many companies entered only one market, how many expanded into two markets, three markets, and so on.

In summary, the collected data enabled to provide a comprehensive overview of company activity within the electronic cigarette industry, spanning multiple technology generations and product markets. By using a variety of sources and creating detailed tables and graphs, the analysis captures both the dynamics of market entry and exit, as well as the overall evolution of the industry. These insights offer valuable context for understanding how companies have navigated the changing landscape of the electronic cigarette and tobacco-heating device markets.

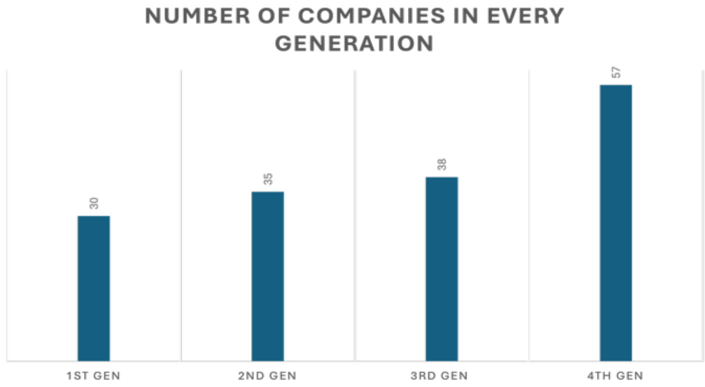
The first figure built using the data set (Figure 4.1) shows the number of entrants per every year, altogether with the year the first product for each generation was introduced.

Figure 4.1: Number of New Companies Entries per Year



It can be noted that the number of entrants increased after the arrival of each new generation. This graph also suggests that the arrival of the 4th generation of e-cigarette and of the first modern disposable e-cigarette may have attracted even more new companies in the industry.

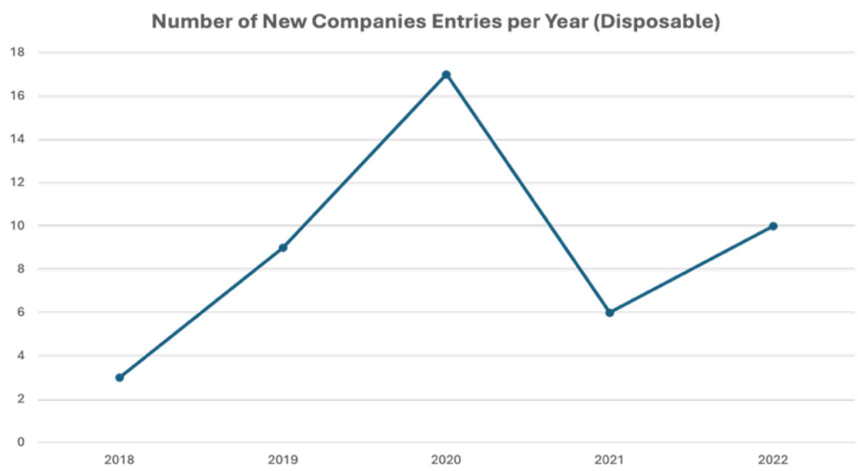
Figure 4.2: Number of Companies in Every



When considering only ENDs (Figure 4.2), the number of new entrants has increased in every generation, as a new industry tends to attract more companies over time.

When considering only disposable devices (Figure 4.3), it is clear that many companies entered the market after the first product was introduced in 2018, and this number may still be growing.

Figure 4.3: Number of New Companies per Year (Disposable)



Furthermore, for each market, the average entry time in years was calculated (Table 4.1).

Table 4.1: Industry Average Entry Time

MARKET	AV. ENTRY TIME (Years)
1st gen	7
2nd gen	4
3rd gen	5,5
4th gen	4
HTPs	6,5
Disposable	4

The table suggests that, when the industry was born, many companies were hesitant and chose not to enter immediately, or large tobacco companies feared the cannibalization of their existing markets. Table 4.2 shows how transnational tobacco companies entered later than other players in every market, except the HTPs one.

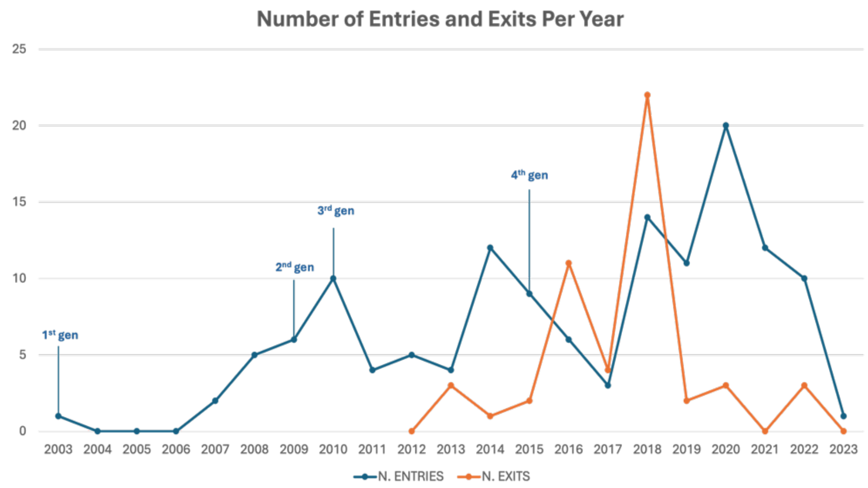
Table 4.2: TTCs Average Entry Time

MARKET	AV. ENTRY TIME (Years)
1st gen	11
2nd gen	6
3rd gen	N.A.
4th gen	3
HTPs	4,5
Disposable	4,5

However, the data may be biased, as information on the earliest electronic cigarette companies is difficult to obtain. On the other hand, it seems that companies were quicker in entering the second-generation and the fourth-generation e-cigarette markets, as well as the modern disposable e-cigarette market.

In the next graph the number of entries alongside the number of exits per year is plotted (Figure 4.4).

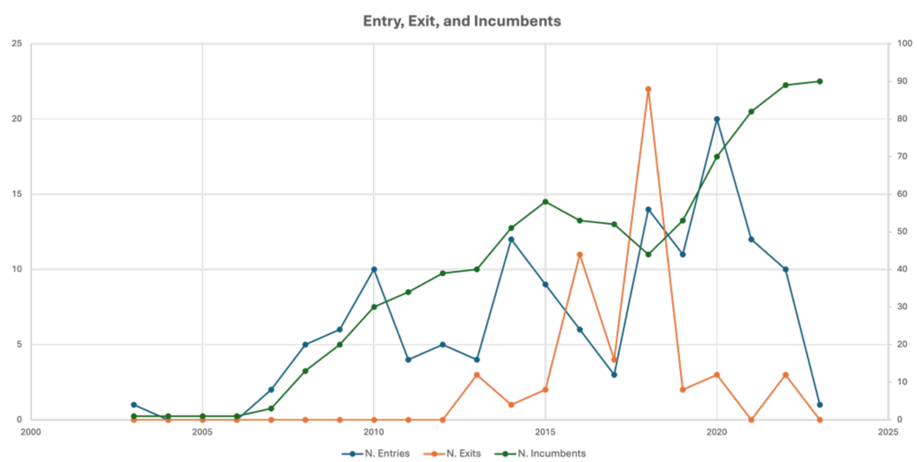
Figure 4.4: Number of Entries and Exits per Year



In this case, it seems that between the years 2014 and 2018 a shakeout may have occurred, since entries declined from 2014 to 2017, while exits grew between 2014 and 2016, and between 2017 and 2018, even though the data might be biased by the approximation of the exit year mentioned above.

When adding the number of incumbents in the industry to the secondary vertical axis of the graph, the potential existence of a shake-out becomes even more evident (Figure 4.5):

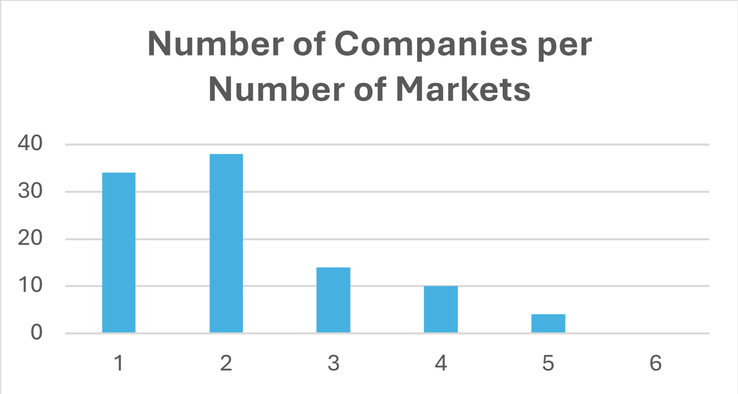
Figure 4.5: Entry, Exit and the Number of Incumbents



The number of incumbents in the industry (right axis) declines between 2015 and 2018 whereas increases again after 2018.

Continuing our analysis it can be noted that, among the companies present in the data set, the majority entered in 1 (34) or 2 (38) markets (Figure 4.6).

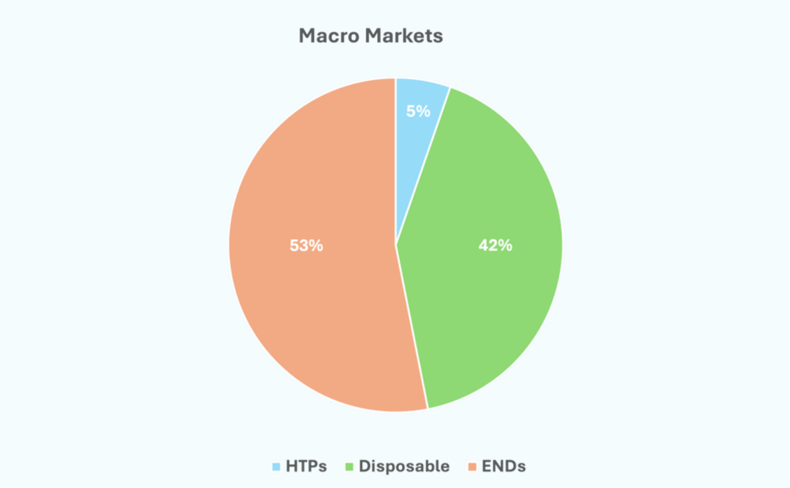
Figure 4.6: N. of Companies per N. of Markets



The number of companies that entered only one market includes those that appear to have specialized in one generation while attempting to differentiate themselves from competitors (e.g., *Billet Box*, a company that produces customizable mod boxs). Some of these firms are e-liquid producers that chose to diversify (e.g., *Suprem-e, Vaporart*), while others are exclusively focused on disposable e-cigarettes, having entered the market during the rise of such devices (e.g., *Elf Bar, Lost Mary*). In contrast, companies that have entered four or more markets seem to be larger companies (e.g., heads of groups with different brands) or large transnational tobacco companies.

Currently, the distribution of firms in the industry is as follows (see Figure 4.7).

Figure 4.7: Macro Markets



The markets for e-cigarettes, in their various forms, continue to dominate, accounting for 53% of the entire industry. In recent years, disposable devices have gained significant traction, and now comprise 42% of the market. In contrast, HTP devices represent a much smaller segment, making up only 5% of the industry.

Interestingly, of the 6 companies active in the HTPs market, 67% are large transnational tobacco companies (TTCs) (4 in total), while only 2 new companies, *Ismod* and *Neafs*, have recently entered this market, respectively in 2020 and 2021. It is evident that the large TTCs have shifted their focus away from electronic cigarettes and concentrated on heat-not-burn devices, after the first introduction by Japan Tobacco International in 2010. In fact, none of the major e-cigarette manufacturers have entered this market. The only competitors the TTCs face in this space are companies that have entered very recently. Rather than fearing the cannibalization of their own markets, it seems that TTCs have intentionally created a separate market from e-cigarettes by utilizing tobacco sticks for their electronic devices. It is, in fact, the e-cigarette companies that appear reluctant to enter the HTPs market.

In conclusion, findings from this descriptive analysis suggest that the industry has undergone significant changes over time, driven by the introduction of new products and the emergence of new markets, which have facilitated the entry of new players. Additionally, it appears that the industry experienced a shake-out between 2014 and 2018.

4.3. Methods

In this section, the methodologies used for this research will be presented.

The study employs statistical regressions, using the average time on the market as the dependent variable in the first case, and the time it took companies to enter each generation, including disposable e-cigarettes, in the second case.

The independent variables employed include: the age of the companies at entry, whether they were transnational tobacco companies or not, the number of markets the company has entered, whether the company is part of a larger group, and whether the company also produces e-liquids. At first, information about the number of markets the company entered has also been included, but, within this dataset, results for this variable have been inconclusive due to problems of collinearity.

Furthermore, for the last regression analyses, information about entry in previous generations was included.

Additionally, the logit model was used to determine what factors potentially influenced exit from every generation.

4.4. Results

In this section, the results from the various regression analyses will be presented and discussed.

Average Entry Time

The first regression model provides insights into the average entry time of firms based on their age at the time of entry, whether they are TTC or not, whether they also produce e-liquids, and whether they are part of a larger group. Table 2.3 presents the results of four different linear regression models used to examine the relationships between the independent variables and the dependent variable, the average entry time. Each model introduces additional variables to observe how the relationships evolve.

Table 4.3: Average Entry Time

VARIABLES	Model 1	Model 2	Model 3	Model 4
CompanyAgeatEntry	-0.00942	0.0247***	0.0246***	0.0246***
	(0.00791)	(0.00847)	(0.00854)	(0.00860)
TTC_dummy		-3.866***	-3.850***	-3.868***
		(0.826)	(0.836)	(0.836)
e_liquid			0.0476	0.0586
			(0.676)	(0.707)
part_of_group				-0.0793
				(0.545)
Constant	9.970***	9.982***	9.973***	9.993***
	(0.221)	(0.218)	(0.225)	(0.234)
Observations	100	100	100	100
F Stat	1.42	11.47	7.68	5.76
Prob > F	0.237	0.000	0.000	0.000
R-squared	0.010	0.070	0.070	0.071

The first model examines the effect of CompanyAgeatEntry on the dependent variable. The coefficient for CompanyAgeatEntry is -0.00942, with a standard error of 0.00791. While the coefficient suggests a slight negative relationship between the age of a company at market entry and the average entry time, the result is not statistically significant. This implies that the age of the company at entry has no noticeable effect on the average entry time.

The model's F-statistic of 1.42, with a p-value of 0.237, indicates that the model as a whole is not statistically significant. Additionally, the R-squared value is 0.010, suggesting that only 1% of the variance in the dependent variable is explained by the company's age at entry. Overall, this model provides limited explanatory power.

In the second model, the TTC_dummy variable is added alongside CompanyAgeatEntry. This addition significantly alters the previous results. The coefficient for CompanyAgeatEntry becomes positive and statistically significant (0.0247***), with a standard error of 0.00847. This indicates that, when controlling for TTC, older companies entering the market are associated with a slight higher average entry time.
The TTC_dummy variable shows a highly significant negative effect (-3.866***), with a standard error of 0.826. This suggests that TTCs enter the market faster than other companies. The overall fit of the model improves, with an F-statistic of 11.47 and a p-value of 0.000, indicating that the model is statistically significant as a whole. The R-squared increases to 0.070, meaning that 7% of the variance in the dependent variable is now explained by the two predictors.

The third model introduces the e_liquid variable, which examines the potential effect on entry time of being an e-liquid producer. The coefficient for e_liquid (0.0476) is not statistically significant (standard error of 0.676), indicating that companies that also produce e-liquids do not have a measurable effect on the average entry time in this model. Meanwhile, the CompanyAgeatEntry coefficient remains positive and significant (0.0246***), and the TTC_dummy coefficient remains significantly negative (-3.850***), demonstrating consistent relationships with the dependent variable across models.
The overall fit of the model remains strong, with an F-statistic of 7.68 and a p-value of 0.000, showing that the model is statistically significant. However, the R-squared remains at 0.070, indicating that the inclusion of e_liquid does not contribute substantially to the model's explanatory power.

The final model introduces the part_of_group variable, which captures whether the company is part of a larger group. The results show that part_of_group has a non-significant coefficient (-0.0793), with a standard error of 0.545. This suggests that being part of a larger group does not significantly affect the average entry time in this dataset.

In this model, CompanyAgeatEntry continues to have a positive and significant effect (0.0246***), while TTC_dummy remains strongly negative (-3.868***), indicating the robustness of these relationships across different specifications. The e_liquid variable remains non-significant.

The model's overall F-statistic is 5.76, with a p-value of 0.000, confirming the statistical significance of the model. The R-squared improves slightly to 0.071, but the change is minimal, indicating that the inclusion of part_of_group does not contribute meaningfully to the model's explanatory power.

Across all four models, two key variables - CompanyAgeatEntry and TTC_dummy - show consistent and statistically significant effects on the average entry time.

The CompanyAgeatEntry variable becomes statistically significant from Model 2 onwards, indicating that older companies at the time of market entry take longer, on average, to enter, even if the coefficient is very small.

The TTC_dummy variable consistently shows a large and statistically significant negative effect across all models. This suggests that transnational tobacco companies experience substantially faster entry compared to other players.

In contrast, the variables e_liquid and part_of_group do not show significant effects in any of the four models. Their non-significance suggests that, within this dataset, these factors do not play a major role in determining the average entry time. It is possible that other factors, not included in the models, have a greater impact.

Finally, while the models are statistically significant overall, the R-squared values remain relatively low, ranging from 0.010 in Model 1 to 0.071 in Model 4, meaning that a large portion of the variance in the average entry time is left unexplained by the included predictors.

Entry Time in Each Generation

The second econometric exercise considers whether the time of entry in each generation has been affected by: company age, whether the company is a TTC, being an e-liquid producer, and being part of a larger group. In this case, the dependent variable is the time of entry in each generation constructed by subtracting the year in which the first product for every generation was introduced to the entry time. The results are shown in Table 2.4.

Table 4.4: Time of Entry for Every Generation

VARIABLES	Generation 1	Generation 2	Generation 3	Generation 4	Disposable
CompanyAgeatEntry	0.00608	0.0498*	0.0293	0.0346**	-0.00105
	(0.0119)	(0.0275)	(0.0244)	(0.0138)	(0.00868)
TTC_dummy	-6.961***	-8.282***	0.141	-4.338***	0.594
	(1.140)	(2.083)	(3.000)	(1.452)	(0.839)
e_liquid	0.326	0.0499	0.919	0.283	-0.767
	(1.736)	(1.445)	(1.093)	(0.758)	(0.533)
part_of_group	0.729	-0.321	0.837	-1.727***	-0.602
	(1.472)	(1.217)	(0.979)	(0.577)	(0.488)
Constant	16.98***	11.68***	10.21***	6.436***	4.489***
	(0.869)	(0.670)	(0.571)	(0.373)	(0.273)
Observations	100	100	100	100	94
F Stat	22.25	5.37	6.46	4.26	1.87
R-squared	0.065	0.055	0.037	0.103	0.055

In the first model, CompanyAgeatEntry has a positive coefficient (0.00608) with a standard error of 0.0119. This result is not statistically significant, indicating that the age of the company at market entry does not significantly impact the time of entry for first generation products. However, in this case the non-significance may be explained by the fact that all companies where new entrants in the first generation, excluding TTCs which were already active in the tobacco industry.

The TTC_dummy variable shows a strong negative effect (-6.961***) with a standard error of 1.140, indicating a highly significant impact. TTCs experience led to a much faster entry into the first generation.

The e_liquid and part_of_group variables are not significant, with coefficients of 0.326 and 0.729, respectively, and large standard errors. This suggests that these factors do not have a significant impact on the time of entry in the first generation.

The model's F-statistic is 22.25, and the p-value is significant, indicating that the overall model is meaningful. The R-squared value is 0.065, suggesting that 6.5% of the variance in the dependent variable is explained by the chosen predictors.

In the second model, focusing on the second generation, CompanyAgeatEntry becomes statistically significant at the 10% level (0.0498*), with a standard error of 0.0275. This suggests that older companies tend to take longer to enter in the second generation.

TTC_dummy remains highly significant and negative (-8.282***), with a standard error of 2.083. Companies within this category enter faster in the second generation.

The e_liquid and part_of_group variables continue to show non-significant results, with coefficients of 0.0499 and -0.321, respectively, suggesting they have no notable effect on the time of entry in the second generation.

The F-statistic is 5.37, and the p-value is significant, meaning the model as a whole is statistically significant. The R-squared is 0.055, meaning that 5.5% of the variation in the dependent variable is explained by this model.

For the third generation, CompanyAgeatEntry has a positive coefficient (0.0293) but is not statistically significant (standard error of 0.0244). This suggests that the age of the company at market entry does not have a significant impact on the time of entry in the third generation. Interestingly, the TTC_dummy variable is no longer significant for Generation 3 (coefficient of 0.141), implying that being a TTC does not influence the entry in this generation. In fact, none of the 4 TTCs produces *mod boxes*.

Once again, e_liquid and part_of_group are not significant, with coefficients of 0.919 and 0.837, respectively.

The F-statistic is 6.46, indicating that the model is significant overall. However, the R-squared is 0.037, suggesting that only 3.7% of the variance in the dependent variable is explained by this model.

In the fourth model, which focuses on entry into Generation 4 products, CompanyAgeatEntry is positive and statistically significant (0.0346**), with a standard error of 0.0138. This suggests that older companies at market entry tend to perform better in Generation 4 products, with a higher level of confidence compared to earlier generations.

In this model, the TTC_dummy is again significant, with a negative coefficient (-4.338**) and a standard error of 1.452, indicating that TTCs enter faster.

The part_of_group variable becomes statistically significant for the first time in this series, with a negative coefficient (-1.727**), suggesting that being part of a group accelerates entry in the fourth generation, while e_liquid remains non-significant (coefficient of 0.283), indicating no effect on Generation 4 entry.

The F-statistic is 4.26, with a significant p-value, confirming that the model is meaningful overall. The R-squared value improves to 0.103, indicating that 10.3% of the variance is explained by the model, the highest explanatory power among the four generations.

In the final model, focusing on disposable e-cigarettes, CompanyAgeatEntry has a negative coefficient (-0.00105) but is not statistically significant (standard error of 0.00868), suggesting no clear relationship between the company's age at entry and the time of entry in this market.

The TTC_dummy variable is also non-significant, with a positive coefficient (0.594) and a standard error of 0.839, indicating no substantial effect on entry.

E_liquid and part_of_group are both non-significant, with coefficients of -0.767 and -0.602, respectively, showing no impact on the dependent variable in this context.

The F-statistic is 1.87, indicating that this model is not statistically significant overall. The R-squared is 0.055, meaning that 5.5% of the variance in the dependent variable is explained, which is relatively low.

CompanyAgeatEntry only becomes significant in Generation 2 and Generation 4. In these cases, older companies tend to take longer to enter.

TTC_dummy is consistently negative and significant for Generation 1, 2, and 4, suggesting that TTCs tend to enter faster than other companies. However, it is not significant for Generation 3 or Disposable products.

E_liquid does not appear to have any significant effect across any of the models, implying that having previous experience as an e-liquid producer does not influence the time of entry.

Part_of_group only becomes significant in Generation 4, where it shows a negative impact on the dependent variable. This suggests that being part of a group leads companies to enter faster in the *pod mod* market. The result might be explained by the fact that having previous experience in other markets accelerates entry.

Entry Time in Each Generation and Entry into Previous Generations

When adding information about whether companies entered previous generations to the model, the results are as following (see Table 2.5).

Table 4.5: Time of Entry Considering Previous Generations

VARIABLES	Generation 1	Generation 2	Generation 3	Generation 4	Disposable
CompanyAgeatEntry	0.00608	0.0429	0.0169	0.0222*	0.00294
	(0.0119)	(0.0277)	(0.0272)	(0.0134)	(0.00420)
TTC_dummy	-6.961***	-3.371	-0.914	-4.731***	-1.048*
	(1.140)	(2.159)	(3.089)	(1.714)	(0.543)
e_liquid	0.326	-0.156	0.947	0.180	-0.212
	(1.736)	(1.013)	(1.132)	(0.683)	(0.475)
part_of_group	0.729	-0.503	1123	-1.632***	-0.209
	(1.472)	(1.066)	(0.901)	(0.546)	(0.445)
stgendummyentry		-5.997***	5.022***	3.112***	3.064***
		(1.200)	(0.921)	(0.584)	(0.620)
ndgendummyentry			-3.196***	-2.261***	-0.499
			(0.921)	(0.446)	(0.544)
rdgendummyentry				-0.889	1.809***
				(0.596)	(0.453)
thgendummyentry					-0.566
					(0.408)
Constant	16.98***	13.31***	9.886***	6.729***	3.242***
	(0.869)	(0.610)	(0.648)	(0.551)	(0.418)
Observations	100	100	100	100	94
F Stat	22.24	11.81	6.49	17.66	13.26
R-squared	0.065	0.294	0.204	0.318	0.422

For the first generation, the results are the same as the previous model, given the fact that there are no previous generations.

CompanyAgeatEntry has a positive coefficient (0.0429) but is still not statistically significant, similar to the previous regression.

TTC_dummy has a much smaller and now non-significant coefficient (-3.371) compared to the strong significance in the previous table, suggesting that the effect of this variable has diminished with the introduction of information on entry in the prior generation.

E_liquid and part_of_group remain non-significant, as before.

Stgendummyentry is introduced in this model, indicating whether companies entered the first generation, and is highly significant (-5.997***), with a standard error of 1.200. This suggests that having entered the first generation accelerates entry in the second one.

In the third generation, CompanyAgeatEntry remains non-significant (0.0169), similar to the model above. TTC_dummy continues to be non-significant (0.141), confirming that it does not have a relevant impact on entry time in the *mod box* market.

Stgendummyentry is positive and significant (5.022***), with a standard error of 1.132, indicating that companies active in the first generation take longer to enter in the third one. This result might be explained by the great differences in technology between the first generation product, the *cigalike*, and the third generation product, the *mod box*.

Ndgendummyentry is introduced (indicating whether companies entered the second generation) and is negative and significant (-3.196***), with a standard error of 0.921, suggesting that *vape pen* producers were significantly faster in entering the third generation.

E_liquid and part_of_group remain non-significant.

The F-statistic of 6.49 and the R-squared of 0.204 show that the model explains 20.4% of the variance, an improvement compared to the previous models.

Concerning the fourth generation, CompanyAgeatEntry becomes significant (0.0222*), suggesting that older companies tend to take slightly longer to enter, as observed in previous regression, while TTC_dummy remains negative and highly significant (-4.731***).
Stgendummyentry remains positive and significant (3.112**), and ndgendummyentry remains negative and significant (-2.261***), showing a consistent effect from previous models.
The new variable introduced, rdgendummyentry, shows if companies were already active in the third generation or not, but it is non-significant (-0.889).
As in the model above, part_of_group is negative and significant (-1.632**), suggesting that being part of a group quickens entry in the *pod mod* market.
The F-statistic is 17.66, and the R-squared is 0.318, indicating that the model explains a greater percentage of the variance compared to previous models.

When considering the disposable e-cigarettes generation, CompanyAgeatEntry remains non-significant (-0.00294), indicating that the company's age does not have a relevant impact on the time of entry in this market.
TTC_dummy becomes negative and significant (-1.048**) compared to the previous results, indicating that TTCs still take less time to enter.
Stgendummyentry (3.064***) and ndgendummyentry (1.809***) are both positive and significant, indicating that companies with previous experience in older generations now take longer in entering the market.
Rdgendummyentry and thgendummyentry (the new variable introduced for previous experience in the fourth generation) are non-significant, as well as e_liquid and part_of_group.

The F-statistic is 13.26, and the R-squared of 0.422 shows that the model explains a much higher percentage of the variance compared to the other models, likely due to the inclusion of all the dummy variables.

In conclusion, the introduction of generation-specific dummy variables has increased the explanatory power of the models, improving our understanding of the time of entry across different product generations.

For the second generation, having previous experience in the earlier *cigalike* market brings incumbents to enter faster the market than new entrants.

With regard to the third generation, having entered the first generation does not represent an incentive to enter, as the technology employed for *cigalikes* is drastically different than the one employed for *mod boxes.* On the contrary, if companies have previous experience in *vape pens*, entry in the third generation is accelerated, as the two generations use similar technologies (e.g., rechargeable devices that employ e-liquids).

When considering the fourth generation, being part of a group represents an advantage for the first time, as companies with experience in different markets enter faster. Furthermore, for the first time, in this generation older companies seem to enter slightly later than newer ones.

For the *pod mod* market, having previous experience in the first generation delays entry, while having entered the second generation accelerates it, likely for the reasons mentioned above. On the contrary, experience in third-generation products is not statistically significant, as *pod mod* devices do not employ e-liquids anymore but use pre-filled and disposable pods.

With regards to modern disposable e-cigarettes, previous experience in the first and second generation delays entry. These results might be explained by the fact that *cigalikes* are obsolete products and are not being produced anymore, while disposable cigarettes employ a different technology and are not rechargeable, as opposed to second generation products.

Even previous experience in the third-generation delays entry, as *mod boxes* devices are rechargeable and employ e-liquids.

Being a transnational tobacco company accelerates entry in all generations, even if the coefficient is significant only for the first and fourth generations and the disposable market. This result seems consistent with model of industrial dynamics, like Keppler's (1996) competitive advantage model, that suggest that larger and more skilled companies enter new markets faster. In fact, TTCs are not only very large companies, but they also have more industry-related skills by being relevant players in the tobacco industry.

Exit

When considering whether exit from each generation is influenced by the same variables used for entry, a logit model was used. Table 4.6 shows the results.

Table 4.6: Exit

VARIABLES	Generation 1	Generation 2	Generation 3
CompanyAgeatEntry	(omitted)	-1.735424**	-0.0361216
		(0.943925)	(0.0392678)
TTC_dummy	(omitted)	209.3705	4.259456***
		(1273.619)	(2.035467)
part_of_group	-0.4950692	-0.1864392	(omitted)
	(0.6310413)	(0.5843069)	
e_liquid	(0.8257119)	1.063792	1.831148
	(0.581)	(0.7496842)	(1.46002)
Constant	-.6637009	1.055345	-3.978886***
	(0.2965333)	(1.026564)	(1.010138)
Observations	71	100	74
LR	0.75	27.81	4.50
Pseudo R-squared	0.0083	0.2246	0.1791

CompanyAgeatEntry has a negative and statistically significant coefficient (-1.735424**) in the second generation, suggesting that older firms are less likely to exit this generation. This result may indicate that more established firms, possibly with greater resources or experience, are more resilient and capable of sustaining their presence in the market during this period.

For TTC_dummy, the coefficient is positive and highly significant in the third generation (4.259456***), indicating that TTCs are significantly more likely to exit at this stage. This result could reflect challenges for transnational tobacco companies in effectively competing or adapting to changing technology and consumer preferences in the *mod box* marked.

Being part of a group and being an e-liquid producer are not significantly associated with the likelihood of exit in any generation.

The fourth generation and the disposable market could not be represented in this model because convergence was not achieved.

4.5. Overview and Conclusions

To conclude this chapter, the comprehensive approach to data collection and methodological accuracy presented here offers a robust framework for analysing the structural and temporal dynamics of the e-cigarette and vaping industry. The dataset developed provides insights across six key markets: the first to fourth generations of electronic cigarettes, heat-not-burn products, and disposable e-cigarettes. By sourcing data from corporate websites, industry publications, and academic resources, we have been able to capture key milestones for 100 companies, detailing their entry and exit patterns across these markets.

The analytical methods employed, including descriptive statistics and regression models, allow us to analyse industry trends and company behaviours. For instance, visualizations illustrate how each product generation's emergence has influenced market entries, exits, and potential shakeouts, particularly noted between 2014 and 2018. These findings are consistent with models such as Gort and Klepper's Industry Life Cycle (1982).

Additionally, the chapter's regression models explain some factors influencing companies' average entry times, such as firm age, multinational status, and whether they were part of larger groups.

Furthermore, the dummy variable analysis reveals significant patterns in how prior experience in one generation impacts entry into subsequent generations. The findings show that transnational tobacco companies and firms with experience in earlier generations often enter newer markets faster, with notable variations in entry time influenced by differences in technological compatibility between generations, consistently with models such as Keppler's competitive advantage model (1996).

When considering the likelihood of exit in every generation, older firms seem less likely to exit. At the same time TTCs are more likely to exit from the third generation, and this could reflect the challenges these large, traditional tobacco companies face in adapting to the rapidly evolving landscape of third-generation electronic cigarettes, which may demand quicker innovation cycles and a departure from conventional tobacco strategies.

However, it is important to also note that the CompanyAgeatEntry variable was constructed broadly, without differentiating age at entry by generation, which may have impacted the results.

In summary, this chapter provides the evidence for understanding market dynamics and company strategies within the vaping industry. These findings not only highlight the evolution of this sector but also establish a baseline and methodological tools for future deeper analysis.

CHAPTER 5: Conclusions

The electronic cigarette industry has shown remarkable dynamism and capacity for innovation over the past two decades. This empirical analysis has explored the patterns of entry and innovation within this sector, highlighting the strategies adopted by major players and the challenges posed by regulatory and technological competition.

Through the analysis of collected data, this study shows that entries in the industry are characterized by various phases of technological innovation, represented by the five generations of devices (with the exclusion of the HTPs market, as it seems to be an oligopolistic one, with only four large companies – even though two smaller companies have recently entered). The results indicate a correlation between waves of innovation and patterns of market entry and exit. For instance, the introduction of disposable e-cigarettes stimulated a new phase of entry by companies focused on quick-consumption products that appealed to a specific consumer base. On the contrary, the introduction of the *pod mod* device appears to have driven many companies out of the market, possibly because this device no longer relies on e-liquids, hence could represent a radical innovation. It also seems that a shakeout has occurred between 2014 and 2018. However, the data gathered suggests that the industry has not reached the maturity phase yet, since new entries still occur, especially after the introduction of the modern disposable e-cigarette. Further research could examine whether a shakeout has occurred and, more broadly, explore the specific phases this industry has experienced.

A key finding from the analysis concerns the importance of both incremental and radical innovation. Results show that experience in previous generations leads to entry in the

following one – experience in the first generation leads to entry in the second one about 5 years earlies, experience in the second generation accelerates entry in the third by about 3 years, while experience in the second generation leads to a faster entry (about 2 years) in the fourth one – unless the technology employed for the new product is radically different from the one employed in the previous generation – companies active in the first generation take 5 years more than other companies to enter in the third one, and 3 years more in the fourth, since the product has radically changed.
Furthermore, transnational tobacco companies took less time to enter than other competitors, demonstrating once again that larger and more skilled companies enter new markets faster.

This thesis also highlighted the influence of regulation on the industry's evolution, with strict rules on nicotine levels, flavour bans, and advertising restrictions reshaping corporate strategies. Regulations have helped shape not only the pace of innovation but also the distribution methods and market positioning, impacting choices for both large and small enterprises.

Looking forward, regulatory trends and evolving consumer preferences will continue driving the industry toward solutions more focused on harm reduction. The growing emphasis on environmental sustainability and public health control could lead to further development of disposable devices and a reduction in the use of non-recyclable materials. It is likely that technological innovation, supported by regulation, will play a crucial role in transitioning toward a more sustainable and responsible market.

In summary, the electronic cigarette industry is a significant example of how innovation can drive change within a complex industry. This analysis provides insight into the entry and innovation dynamics that characterize the industry. Additional future study could deeper analyse, for example, whether every generation constitutes a submarket and how those submarkets influence industry evolution.

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