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Industry Evolution in Varieties of Capitalism: a Comparison between the Danish and US Wind Turbine Industries

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Abstract

Klepper developed a theory which explains the evolution of industries on the basis of firm routines. The Varieties of Capitalisms approach, however, argues that the actions of firms depend on their institutional environment, which would have an effect on industry evolution. We connect theses two approaches by using entry types of the Klepper-framework as different forms of resource transfer from established to a new industry. From the Varieties of Capitalism approach, we derive assumption on how institutional differences affect resource transfer from old to new industries. We expect that resource transfer to new industries in coordinated market economies takes place in stronger connection to established industries, marked by diversifiers and entries from related industries. We expect that resource transfer to new industries in liberal market economies takes place more independent from established industries and therefore faster, marked start-ups, spinoffs and a faster industry formation. Using 28 US and 32 Danish wind turbine manufacturers from 1974 to 2009 as example, we found in the US a faster industry formation, a better performance of spinoffs and a better performance of start-ups. In contrast, diversifiers performed better in Denmark.

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Introduction

There are different explanations of the driving forces behind the evolution of industries (Abernathy and Utterback 1978, Murmann and Frenken 2006). Klepper developed a heritage theory which explains the evolution of industries based on firms' routines (Klepper 1997, Klepper 2001). Firms perform according to their pre-entry experience. Those with the best routines in terms of their R&D investments steadily increase the competitive pressure in an industry, which results in a shakeout of less competitive firms (Klepper and Simmons 2000).

This focus on purely firm-specific factors determining industry evolution is contrary to expectations from an institutional perspective (Nelson 1993, Boyer 1997, Hall and Soskice 2001, Coriat and Dosi 1998). Institutional approaches would argue that the evolution of firms and industries is affected by the institutional setting in which they are embedded (Lundvall 1988, Cooke 1992, Saxenian 1994). From this point of view, institutional differences would lead to deviations in evolution not only between industries (Malerba 2002), but also between regions and countries (Piore and Sabel 1984, Martin 2000).

However, all studies that apply the heritage framework, examining a wide variety of industries, including automobiles (Klepper 2007; Boschma and Wenting 2007), tires (Bünstorf and Klepper 2009), book publishing (Heebels and Boschma 2011), fashion houses (Wenting 2008) and semi-conductors (Klepper 2010), provide evidence for the main lines of the theory. Furthermore, studies on industries such as laser manufacturers in the US (Klepper and Sleeper 2005) and Germany (Buenstorf 2007) as well as of automobile manufacturers in the US (Klepper 2002), Germany (Cantner et al. 2006) and Great Britain (Boschma and Wenting 2007), which allow for inter-country comparisons, also show comparable results. The few deviations are explained by the peculiarities of the specific cases. For example, the longer time until the shakeout in the German automobile industry compared to the US industry is explained by the slower market formation (Cantner et al. 2006); the larger number of spin-offs in the German laser industry compared to that of the US is interpreted as a sign of entrepreneurial opportunities (Buenstorf 2007).

Admittedly, these are small differences. Nevertheless, the question is whether these differences in industry evolution are random or whether they reflect a structural bias accruing from institutional differences. Answering this question requires the integration of assumptions on how institutions affect the evolution of firms and industries into the heritage framework. For this task, we use the Varieties of Capitalism (VoC) approach developed by Hall and Soskice (2001). Like the heritage theory, the VoC approach focuses on the firm as a unit of analysis. Their common unit of analysis allows the derivation of assumptions on firm performance from the VoC approach, which can be tested in the heritage framework. Nevertheless, they differ in key assumptions about what influences firm performance. While Klepper (1996, 2002) argues that firms' routines affect firm performance, the VoC approach argues that firms benefit when their activities are compatible with their institutional environment (Hall and Soskice 2001). Aggregate outcomes from the activities of firms diverge into two ideal types of capitalism: liberal market economies (LME) and coordinated market economies (CME). Each type encourages behaviour by firms that is suited to its specific institutional configuration and penalizes it otherwise. Taking this into account, a VoC perspective would expect differences in the evolutionary pattern of an industry between an LME and a CME.

To analyse differences in industry evolution between LMEs and CMEs, we apply a survival analysis to US and Danish wind turbine manufacturers between 1974 and 2009. There are a number of reasons for this selection. First, the VoC approach already assigned the US and Denmark to two different institutional systems: the US as an example of an LME, and Denmark as an example of a CME (Hall and Soskice 2001, c.f. Campbell and Pedersen 2007). Second, as VoC studies aim to understand contemporary differences between countries, they usually cover the time until the 1970s (Hall and Gingerich 2009). This constraint requires the analysis of an industry that has evolved since then, and rules out older industries such as automobiles. Third, the industry grew to a considerable size in both countries around the same time. And finally, there are already several qualitative studies on the WEC industries in Denmark and the US (Karnøe 1999, Garud and Karnøe 2003, Van Est 1999), which provide an in-depth investigation of institutional differences between the US and Denmark with regard to the wind turbine industry.

Klepper's Heritage Theory

The heritage theory of Klepper is mainly based on three observations: most industries experience a shakeout, marked by a number of exits; firms and entrepreneurs with experience in the same or a related industry outperform entries without that experience; and the performance of firms is related to the performance of their parent firms (Klepper 1996, Klepper 2001, Klepper 1997).

Based on these observations, Klepper developed a theory which explains industry evolution through the inheritance of firms' routines. His theory is based on three different lines of argument (Klepper 2002). The first concerns the quality of firms' routines. Entries benefit from previous experience in other or related fields, or from the quality of their parents' routines in the case of spin-offs. The better a firm’s routines, the better it performs. Furthermore, better-performing firms reach the size at which they generate spin-offs sooner. Since spin-offs inherit the routines of their parent firms, they also grow more quickly and may, in turn, spin out new firms sooner. The second line of argument says that firms with better routines also attract better employees. This in turn leads to further improvements in routines, faster growth and earlier generation of spin-offs. The third line connects the individual firm with industry dynamics. Firms reduce product prices by investing in R&D.

When prices drop beneath a certain threshold, a shakeout occurs and only the most competitive firms survive. Early entrants have more time to invest in R&D, and firms with better routines can invest larger amounts, i.e. early entries with pre-entry experience are especially likely to survive the shakeout (Klepper 1996, Klepper 2002).

In the following section, we describe the studies which analysed the automobile industries in the US (Klepper 2002), Germany (Cantner et al. 2006, Von Rhein 2008) and Great Britain (Boschma and Wenting 2007) in more detail, as they allow for a comparison between countries. Arguing that these past developments are reflected in institutional differences today would be a bold assumption, even if national institutional systems remain remarkably stable over time (Nelson 2002). But this comparison gives an impression of the differences in industry evolution between different institutional systems.

Table 1 presents information on the time of industry formation, defined by the number of years from the establishment of the first firm until the start of the shakeout; the percentage of intra-industry spin-offs (i.e. entries with previous experience in the respective industry[1]) and experienced entries (i.e. diversifiers, entrepreneur previously heading a firm in another industry, and entries from related fields; we indicated different measures of relatedness in a footnote) as well as how this pattern changes over time. The table also includes the hazard rates of experienced entries and spin-offs compared to inexperienced entries. As most studies compare different models, we give the results for the model with the least variables, which nevertheless includes different entry cohorts and pre-entry experiences, as well as allowing differentiation between entry time and experience. As experienced entries are defined in different ways, which also affects the composition of inexperienced firms, this comparison can only be a rough indicator of inter-country differences at best.

[1] Buenstorf (2007) indicates that also this measure can imply different definitions, which might result in different numbers.

The table shows that the duration of the period of industry formation differs widely, from 12 years in the US to 38 years in Germany. The proportion of spin-offs also differs. It ranges from 20 per cent in the US to 11 per cent in Germany. The temporal changes to the entry patterns can only be compared between the US and Great Britain. While the US industry shows a decreasing proportion of diversifiers and an increase in spin-offs over time, this ratio is stable in the British industry. All studies show better survival rates for experienced firms and the studies that consider spin-offs also found lower hazard rates for these. The US studies exhibit the smallest advantage of pre-entry experience over inexperienced entries. However, this difference is surely affected by the different measures of pre-entry experience.

Overall, the overview shows that the industries in the three countries differ, in particular in the duration of industry formation and entry pattern over time. These differences are argued to emanate from the particularities of the industry or the individual case (Simons 2001). According to Cantner et al. (2006: 56), for example, the slower industry formation in Germany is the result of smaller-sized firms and the specific market development in Germany. Nonetheless, the question arises of whether such idiosyncratic explanations can be traced to more general institutional differences between countries.

Study	*t* industry formation	% entry exp vs. spin-offs	% entry exp vs. spin-offs over time	Hazard rates of Exp/Spin in % compared to inexperienced firms[2]
Klepper (2002), US	12	31[3]/20	exp[4] / spin 1. 42 / 7 2. 28 / 17 3. 26 / 35	-37[5]/-49 (Model 4)
Cantner et al. (2006); Germany	38	56[6]/	exp / spin 1. 75 / 2. 67 / 3. 50 / 4. 49 /	-55/ (Model 3)
Von Rhein 2008); Germany		46/ 11[7]/	Not applicable	-58/-74 (Model A)
Boschma and Wenting 2007); Great Britain	25	68[8]/ 17	exp / Spin 1. 75 / 15 2. 63 / 19 3. 65 / 17	-57*/-73* (Model 3)

Table 1: Comparison of the evolution of the automobile industries in the US, Great Britain and Germany

[2] The relevant formula is 1-exp(beta)*100 (c.f. Klepper 2002, Cleves et al. 2008).

[3] The total number of firms is 713, with 120 experienced firms, 108 experienced entrepreneurs and 145 spin-offs.

[4] Based on Table 1 in Klepper (2002: 653).

[5] Reduction of the weighted average of hazard rates for experienced firms and entrepreneurs. The reduction for firms and entrepreneurs with experience in bicycles, engines, carriages and wagons is 54%.

[6] Firms and entrepreneurs with a background in a related industry (most frequently carriages and wagons) or the same industry, spin-offs are subsumed under this category.

[7] Von Rhein (2008) uses the same data set as Cantner et al. (2006), which allows a differentiation between the figures for spin-offs and experienced firms. Their data set comprises 349 firms, among them 196 experienced firms. Experienced firms comprise 56% of all entrants. From the 37 spin-offs indicated by von Rhein (2008), we can calculate 159 experienced firms, resulting in 46% diversifiers and 11% spin-offs.

[8] I.e. experience in related industries such as bicycle or coach building, or semi-related industries such as engineering.

Varieties of Capitalism and Industry Evolution

The VoC provides a framework that allows the elaboration of expectations on how institutions affect firms' behaviour. The basic assumption of the VoC is that firms choose forms of coordination that are institutionally supported. Institutional differences between countries lead to different behaviours of the respective firms, while institutions, conversely, adapt to economic practices and actions (Hall and Gingerich 2009, Hall and Soskice 2001). Institutions are complementary, i.e. they are interdependent and the "presence (or efficiency) of one increases the returns from (or efficiency of) the other" (Hall and Soskice 2001: 17). These complementarities make alterations to individual institutions more difficult and consolidate or reinforce institutional differences between countries. Based on this framework, the VoC approach distinguishes between two archetypes of capitalism: liberal and coordinated market economies. In LMEs, coordination mainly takes place via markets, competitive relations, contracting and internal corporate hierarchies. In CMEs, non-market institutions support strategic interactions and collaborations, which serve to address and align the needs of different stakeholders (Hall and Soskice 2001). For example, labour markets in LMEs are shaped by flexibility and investment in general skills that can be applied to different jobs, while labour markets in CMEs are shaped by long-term relations and investment in specific assets.

Unfortunately, the VoC approach does not deal conclusively with the evolution of industries. However, it makes assumptions on how different forms of coordination affect the way firms allocate their resources and shift their resources to new fields of activity. LMEs allow for quickly adjusting and switching processes and resources. This capacity allows a comparatively easy exploitation of technological developments outside of existing paths or paradigms by firms in LMEs. In CMEs, long-term relationships favour incremental development. Firms in CMEs benefit from investing in assets "whose returns depend heavily on the active cooperation of others" (Hall and Soskice 2001: 17).

These differences in resource allocation lead to different prevailing modes of innovation. The VoC approach assumes that LMEs are better suited to radical innovation while CMEs are better suited to incremental innovation. This assumption regarding the structural differences in innovation between LMEs and CMEs is challenged by empirical studies. Using patent data, Taylor (2004) shows that the US is actually the only country specialized in radical innovation. Akkermans et al. (2009) indicate, also based on patent data, that both LMEs and CMEs can specialize in radical innovation, but in different fields: LMEs in chemical products and electronics, CMEs in machinery and transport equipment.

However, the distinction made by Hall and Soskice (2001) regarding innovative activities refers not to how radical an innovation is, but to the way resource allocation is rewarded. LMEs reward resource allocation when it is independent from established structures and takes place in new fields, while CMEs reward resource allocation when it exploits synergies with existing structures and takes place in established fields (c.f. Akkermans et al. 2009). Accordingly, Hall and Soskice (2001: 38f, emphasis in original) distinguish between

> "*radical* innovation, which entails substantial shifts in product lines, the development of entirely new goods, or major changes to the production process, and *incremental* innovation, marked by continuous but small-scale improvements to existing product lines and production processes."

Established industries are marked by distinct resources and institutions (Malerba 2002). Emerging and growing industries must develop these specific assets and supporting institutions over time (Boschma 1997). They are thus dependent on resource transfers from established industries (Storper and Walker 1989). From a VoC perspective, shifting resources into new fields is easier in LMEs compared to CMEs and firms in LMEs benefit from the independence from established fields, while firms in CMEs benefit from their connection to them. Accordingly, we would expect that the differences between LMEs and CMEs in the way they transfer resources from established industries to new industries affects industry evolution: new industries in LMEs evolve more loosely, while new industries in CMEs evolve with tighter connections to established industries.

The Heritage Theory from a VoC Perspective

The heritage framework distinguishes entries according to their relation to the new industry. This distinction makes it possible to analyse differences in how resources are transferred into a new industry. The heritage framework depends on two sets of key variables: one set measures different qualities of pre-entry experience. The granularity ranges from a simple separation between firms with production experience in the same or related fields and inexperienced startups (Cantner et al. 2006) to differentiation between entrepreneurs and firms, different degrees of relatedness (Klepper 2002, Boschma and Wenting 2007) and forms of spin-offs (Buenstorf 2007). The second set of variables consists of time data on firm entry and exit. This data allows the classification of entries according to the phase of the industry life cycle, time of industry evolution and the construction of survival time as a dependent variable.

We operationalise the processes assumed by the VoC approach within the Klepper framework in the following way: New industries depend on entries (Klepper 1996). We use firm entries as an indicator for resource transfers and the generation of the new industry. The heritage-theory framework describes four forms of connection to established industries (Klepper 2002, Boschma and Wenting 2007). The first is entry by diversification. The connection to established fields is obvious for diversifiers, which still remain active in other industries, at least for a while. They also might apply established production competencies into the new industry. The second form is entry from related fields. Entries with knowledge in related industries transfer more specific and technologically related routines to the new industry (Frenken et al. 2007, Boschma and Wenting 2007). Both firms and entrepreneurs can enter from related fields. The third form is the intra-industry spin-off. In contrast to the previous entries, which benefit from connections to established industries, intra-industry spin-offs are formed using resources already built up in the new industry. The last category comprises startups without experience in related industries. This form has the weakest connection to established resources in the new industry.

In addition to connections with related fields, the VoC framework would also expect different rates of resource transfer to new industries in LMEs and CMEs. The entry and exit dates of firms serve to analyse the timing of resource transfers and to analyse differences in temporal patterns. The time span from the first entry until the start of the shakeout serves as a measure of the speed of industry formation. Finally, length of survival allows us to differentiate between different firms' performances.

We expect that the differences in resource transfer in CMEs and LMEs will affect entry patterns, the duration of industry formation and the performance of different entry types. Entries in CMEs are more constrained by established resources, while firms in LMEs can act more independently of them. We therefore expect a larger proportion of entries in CMEs to adhere to established industries, either in terms of production experience or regarding technological relatedness (Breschi et al. 2003). Accordingly, we expect more startups and spin-offs in LMEs. Additionally, we expect the disadvantages of CMEs when it comes to freely transferring resources into new fields to result in a slower rate of firm formation.

We also expect that firms the institutional system affects the internal organisation of the firm. Accordingly, firms in CMEs will have a lower capability to transfer resources into R&D and thus show a slower increase in productivity than firms in LMEs (Klepper 1996). As this increase in productivity causes the shakeout, we expect a longer time span between the first entry and the start of the shakeout in CMEs than in LMEs, as an indicator of the duration of industry formation.

Furthermore, we also expect that these differences in industry formation will also affect temporal patterns of entry. The heritage theory expects diversifying firms at the beginning and spin-offs in later phases. We assume a slower industry formation in CMEs and assume entries to benefit from resource transfers from established industries for a longer period of time. As a result, we expect diversifying firms and entries from related fields in CMEs to enter to a considerable extent at industry maturity as well, i.e. the assumed overall differences in entry pattern would mostly arise from differences in the later stages.

Finally, the heritage framework makes it possible to measure the performance of different entry types. The heritage theory expects that firms with better routines will perform better, while the VoC approach would expect that firms' performance depends on how the firms' actions relate to their institutional environment. We expect those firms to perform better in CMEs that can exploit synergies with established fields, i.e. diversifiers and entries benefiting from knowledge in technologically related fields. In contrast, we expect firms to perform better in LMEs that allocate their resources independently of the requirements of other fields, i.e. startups from unrelated fields, as well as spin-offs that benefit from resources already established in the new industry.

We expect this general assumption to also be mediated by temporal development. The heritage theory assumes changes in firms' performance during the industry life-cycle (Klepper 1997). Investments in R&D by early entrants can hardly be made up for by later entrants, with the result that early entrants often outperform later entrants. Industry formation and the establishment of a particular production system is assumed to take longer in CMEs, and firms in CMEs benefit when their activities relate to established resources. We therefore expect late-entering diversifiers and general entries that benefit from knowledge in related fields to have a smaller disadvantage in CMEs than in LMEs.

	No. of early	late	Performance of early	late
startups	0	-	0	-
diversifiers	0	+	0	+
relatedness	0	+	0	+
spin-offs		-		-

Table 2: Expectations regarding entry and performance of firms in CMEs compared to firms in LMEs

Klepper developed his theory on US industries (Klepper 2002, Klepper 2001, Bünstorf and Klepper 2009). The US is considered a paradigmatic example of an LME (Kenworthy 2006, Akkermans et al. 2009). We therefore adopt his theory as a baseline model for LMEs. In addition to the longer expected time span between first entry and the start of the shakeout, Table 2 summarizes our assumptions on entry pattern and firms' performance in CMEs compared to LMEs.

Varieties of Capitalism, Policies, Resource Transfer and Innovation in the US and Danish Wind Turbine Industries

All accounts agree that the US is a liberal market economy (Hall and Soskice 2001, Campbell and Pedersen 2007). Some even argue that the US is too typical an LME to compare it with other forms of LME such as the UK or Canada (Taylor 2004, Kenworthy 2006). The classification of Denmark as a CME by Hall and Soskice (2001), however, is controversial. While Hall and Gingerich (2009) confirm that Denmark is a CME, Kenworthy (2006) defines Denmark as an intermediate form and Campbell and Pedersen (2007) argue that Denmark is a hybrid form of capitalism[9]. This tentativeness requires elaborating the extent to which the developments in the US and Danish wind turbine industries correspond to the categorizations of the VoC approach.

Fortunately, the institutional underpinnings of these two industries are well-analysed. The studies by Karnøe (1999) and Garud and Karnøe (2003) are particularly useful in this regard, as they analyse how institutional differences caused actors in the two industries to take different approaches to innovation: a technology-driven "breakthrough" approach in the US, and an interaction-driven "bricolage" approach in Denmark (Garud and Karnøe 2003). Yet, they do not assign the differences to different forms of capitalism but trace the reasons for the different approaches to the stronger implementation of Fordist and Taylorist modes of organization in the US compared to Denmark (Karnøe 1999). But the richness of their accounts on institutional differences between the US and Danish wind energy industry allows to assess their differences from a VoC perspective, especially how these institutional differences affected transfer of resources into the emerging industries.

In the US, organisation of production was marked by a large degree of separation between tasks (Karnøe 1999). Garud and Karnøe (2003) describe a high degree of division of labour within US wind turbine producers, marked by a strong division between blue- and white-collar workers. Different tasks such as design and production were strongly separated. Even maintenance and ownership of windmills were separated, as windmills were treated as financial investments. US firms had a strong emphasis on in-house research and knowledge-related collaborations between firms were limited. Inter-firm exchanges were highly formalized and took place on a market-based level.

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[9] Campbell and Pederson (2007) a liberalization of labour market and industry policy in Denmark in the 1990s. It is unclear to what extent these changes affected the wind turbine industry, which already started in the 1970s. In contrast, the analysis of Kenworthy (2006), spanning the years 1970 to 2000, overlaps with our period of investigation.

Danish firms organized their relations and innovation processes in a different way. In contrast to the US, pre-Fordist forms of craft-based production and worker education remained important in Denmark (Karnøe 1999). The separation between the tasks of the production process was thus less sharp, design and production were strongly interlinked, hierarchical differences were less pronounced. This form of organization requires a high degree of interaction, not only between different departments within a single firm, but also between firms and with windmill owners, which were mostly single users in Denmark, most of them organised within the Wind Mill Owners Association (Garud and Karnøe 2003).

In addition to learning and division of labour, also forms of state action differ between the US and Denmark. In the US, in addition to 900 million USD in tax exemption, the industry benefited from a research programme involving, among others, NASA, the US Department of Energy, as well as technology-driven manufacturers from aircraft construction, accounting for 486 million USD between 1974 and 1992 (Gipe 1995, Table 3.2). This research programme also involved universities that offered courses in wind-turbine design from the mid-1970s onwards (Karnøe 1999). Additionally, the Solar Energy Research Institute (later National Renewable Energy Laboratory) which offered research grants started research in wind turbine design in 1977. These activities were, for the most part, devoted to basic research, with the intention of achieving breakthroughs in wind-turbine design.

Compared to the US, resources invested into the new industry were small in Denmark and accounted for 53 million USD in basic research and about 150 million USD in subsidies and tax exemptions between 1974 and 1992 (Gipe 1995, Table 3.2). As in the US, also a research institute with focus on wind energy formed, the Danish Wind Turbine Test Station (DWTS) in 1979, As the state demanded that wind turbines be approved by the DWTS, but standards were unclear turbine manufacturers collaborated with the DWTS to get their systems approved and collective learning processes evolved around this institute (Karnøe 1999).

The different institutional settings in the US and Denmark affected technological approaches. The “breakthrough thinking” (Karnøe 1999) in the US that was formed by its institutional setting led to a light-weight model, characterized by the combination of rapid rotation, use of light materials, and large developmental steps between each product generation (Garud and Karnøe 2003). This approach was mainly driven by the large firms form the aviation industry that tried to adapt their aerodynamic expertise on wind turbines.

In Denmark, firms started from a design that had been invented by Juul in the 1950s, which had proved to be reliable (Garud and Karnøe 2003). Each firm improved the design incrementally. Improvements were imitated by other firms, even if the underlying principles were not understood. New designs were marked by only incremental improvements, but short periods of development (Garud and Karnøe 2003). The "Danish Design" (Heymann 1995, Oelker 2005) that resulted from this “bricolage” approach (Garud and Karnøe 2003) was a rather simple and heavy construction. Due to the few resources devoted to the new industry, entries were mostly small firms and entrepreneurs that adhered to local competencies in the construction of agricultural machinery, shipbuilding or even skilled crafts like blacksmithing.

These descriptions of innovative practice and industry evolution are what would be expected from a VoC perspective. The institutional setting in the US favours a high degree of market-based coordination, which made a rapid transfer of resources into the WEC industry possible. The institutional setting in Denmark favours a more relational and interactive mode of coordination. Fewer resources were devoted to the industry and the industry developed incrementally. However, both industries experienced considerable input from related industries: the US industry adopted a science-based approach with strong relations to universities and the aircraft industry, while the Danish industry benefited from agricultural machinery construction, which is marked by relationships with farmers as the first users of wind turbines. The respective policies also follow the assumed pattern. LME policies are expected to comprise “tax incentives, vocational programs focused on formal instruction in marketable skills, and government subsidies for basic research” (Hall and Soskice 2001: 49). These were exactly the policies applied in the US. Policies in CMEs are expected to focus on coordination between firms' activities, with the state perhaps transferring the coordination task to particular stakeholders (Hall and Soskice 2001). In the Danish case, the stakeholder coordinating firms' activities was the DWTS. To conclude, the US industry was shaped by a strong division of tasks and function and the intention to quickly build up a distinct base for the industry, while the Danish industry evolved more in connection to established resources and by coordination of activities.

Data and Variables

Our quantitative comparison of the US and Danish wind-turbine industries is based on an original database. We gathered data on the time of entry and exit of on-shore wind turbine manufacturers, pre-entry experience and applied technological design. A company was integrated into the database if it installed at least one wind turbine. Additionally, this wind turbine should have grid connection. This condition rules out producers of small scale wind turbines, which are for example used to power water pumps on farms. We define entry as the beginning of production. Exit is marked by the end of production. The last investigated year in our data set is 2009.

We distinguish between several forms of pre-entry experience. Spin-offs are firms whose founders have a background in the same industry (Boschma and Wenting 2007, Klepper 2007). Diversifiers are entries that were also still active in other industries, at least for a certain amount of time. The remaining group consists of start-ups. We also consider entry from a related industries. Qualitative accounts consider the aircraft industry as well as universities as an important source of firms in the US, and agricultural machinery, as well as shipbuilding a source of firms in Denmark (Gipe 1995, Karnøe 1999).

We also have to account for the fact the demise of the US industry is connected to its technological approach, and the survival of firms might be dependent on the adopted wind turbine design (Garud and Karnøe 2003). Therefore, we divided the technological designs into two main categories: light-weight design, which was the US approach, and the Danish design which became the dominant design (Heymann 1995). The remaining category includes other technological approaches such as the Darreius design with a rotation on the vertical axis. The classification of technological designs was made based on product specifications or pictures of the wind turbines in question.

Data has been collected from several sources. Older data was mainly gathered from literature (for example Gipe 1995; Heymann 1995; Oelker 2005; Righter 1996; Van Est 1999; Gilles 2008; Karnøe and Jørgensen 1995), while more recent data was collected from trade journals (Windpower Monthly; New Energy; North American Wind Power) or company journals (Enercon Windblatt; Nordex Windpower Update, VestasInside), as well as the Internet (www.windsofchange.dk). If possible, missing data was supplemented by telephone interviews and visits to trade fairs. In total, we collected data on 32 Danish and 32 US firms.

Data is missing for 12 of the 65 firms. Due to the small firm population and since the missing data is biased towards small US-based firms that were active during the Californian wind subsidy bubble of 1981-1985[10], we applied heuristics to fill in the missing data. Assumptions regarding year of entry and exit, as well as the design, were based on the available firm information (e.g. technology, home country, entry date or exit reason, etc.) in connection with the dominating market trends at the time. For example, when we could not find any sign of

[10] Tax reduction in California starting from 1978 led to a bubble in the wind-turbine industry in these years. Until the mid-1980s, 97% of all wind turbines worldwide were installed in California (Karnøe 1999: 184). The bubble ended with the expiration of the tax reduction in 1986.

activity for a firm after the California wind rush, we assumed its exit at the end of the bubble. In doing so, we assessed years of entry or exit for 5 firms. We assumed 3 firms with unknown pre-entry experience to be unrelated startups. Four firms, all of them US-based, had more than one missing variable. We omitted these firms from the further analysis.

Evolution of the Wind-turbine Industries in the US and Denmark

The following sections compare the patterns of entries in Denmark and the US as well as the industry development.

Entry Patterns

Figure 1 compares the quantitative development of the industries in the US and Denmark. We assumed a longer time period from first entry until shakeout in the Danish industry. The figure shows that both industries experienced a shakeout and thus followed the pattern of most industries (Klepper 1997, Simons 2001). However, the growth phases and shakeouts at the national level took place at different points in time. The first firms formed in the US in 1974[11]. The industry peaked in 1980 and 1982, with 17 manufacturers. After 1984, a shakeout started. Thus, the time period from first entry until shakeout is 10 years. Danish firms began manufacturing in 1975. The industry peaked in 1987, and the shakeout took place after 1987.[12] The respective period from first firm until shakeout for Danish firms is 12 years. This reflects our assumption that the slower transfer of resources to new industries in CMEs results in a slower formation of the industry.[13]

[11] The first Danish firms followed in 1976. This contradicts accounts on the earlier wind-energy activities in Denmark (e.g. Karnøe 1999). As our data consists of manufacturers on the market, it does not capture this era of experimentation, mostly by craftsmen, which took place before 1976.

[12] A robustness check excluding firms with incomplete data resulted in an earlier start of the shakeout in the US industry, namely after 1983, and indicates an even faster industry formation.

[13] The expiration of the tax reduction in California that ended the California wind rush and may have caused the shakeout of US firms occurred three years after the shakeout of US firms, i.e. in 1986. It rather seems that the expiration of the tax reduction affected Danish firms, and not US firms.

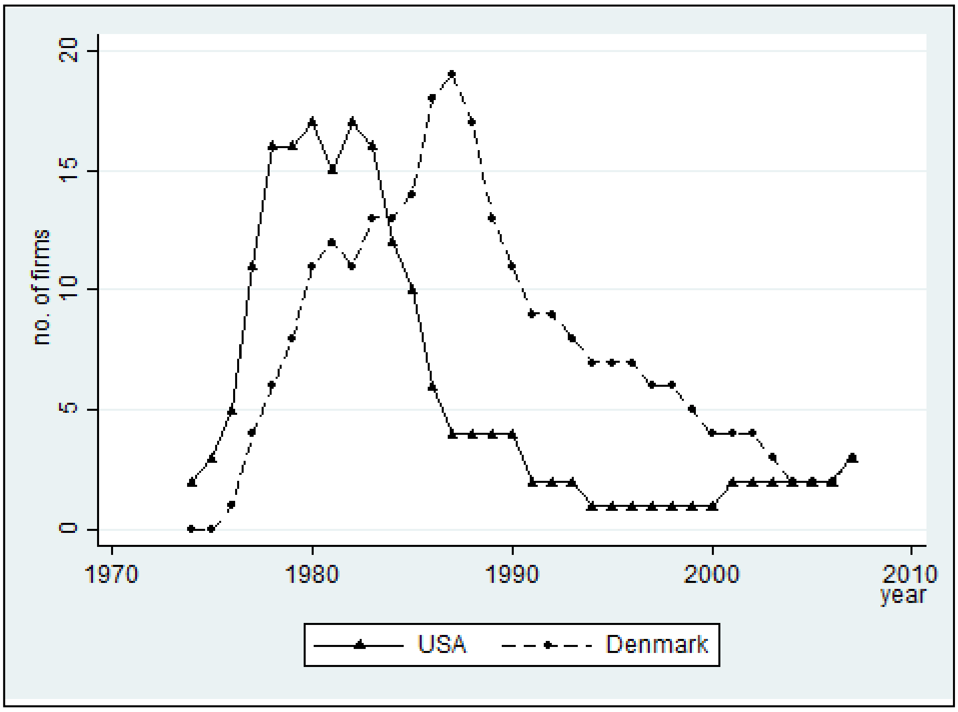

Figure 1: Industry development in the US and Denmark

Table 3 shows that both industries are shaped by entrants from related fields. However, which fields these are differs greatly: the aircraft industry in the US and rural industries such as agricultural machinery in Denmark. Also the only entry with a background in shipbuilding was in Denmark. A larger number would be expected from literature, but the marine industry seems to be more important on the supplier side (Karnøe and Garud 2012). We also found a much larger number of entries whose founders were employed at a university or a research institute in the US than in Denmark. Therefore, we have a US industry which is dominated by technology driven entries from universities or the aviation industry and a Danish industry which is dominated by rural producers of agricultural machinery. Furthermore, not all these forms of relatedness benefit firm survival. Garud and Karnøe (2003) show that US aircraft producers failed in applying their aerodynamic on wind turbines. Due to the differences and unclear effect of relatedness, we omit this category from further analyses.

		US	Denmark	Total
unrelated		10	19	29)
related	total	12	8	20
	aircraft industry	7		
	university	5	2	
	agricultural machinery		5	
	shipbuilding	0	1	
spin-off		6	5	11
total		28	32	60

Table 3: Comparison of relatedness

A measure for resource transfer which is better to compare is diversification. This indicator leads to a distinction between diversifiers, spin-offs and startups. To allow a comparison of US and Danish entry cohorts according to their stage during industry evolution, and to gain comparable numbers, Danish and US cohorts use different time ranges. Compiling US entries from 1974-1978 and 1979-2009 and Danish entries from 1975-1982 and 1983-2009 results in cohorts of 12 to 18 entries. The length of time covered by the second cohort reflects the fact that only a few firms - three in the US and one in Denmark – entered after the shakeouts in their respective countries.

US				**Denmark**			
	Cohort1	Cohort1	Total		Cohort1	Cohort2	total
Start-ups	6	3	9	Start-ups	8	7	15
Diversifiers	10	4	14	Diversifiers	9	3	12
Spinoffs	0	5	5	spin-offs	1	4	5
Total	16	12	28	Total	18	14	32

Table 4: Comparison of pre-entry experience ($p<0,05$ for the US)

Table 4 shows only shows small differences between the US and Denmark in the total number of diversifiers, spin-offs, start-ups and entries from related industries. We did neither find more spin-offs in the US nor more diversifiers in Denmark. Indeed, the numbers are quite similar. The same accounts for the temporal pattern of entries. Both industries were marked by early diversifiers and later spin-offs. The only difference is the large number of start-ups in Denmark, which is contrary to our assumption. Their number might reflect the industry's beginnings among skilled craftsmen and individual entrepreneurs (Karnøe 1999). To conclude, we could not find a difference in entry pattern as expected.

Genealogical Development

Figure 2 shows the genealogical development of wind turbine manufacturers in the US and Denmark. It includes entry, exit, design, and if the firm only managed to produce prototypes or experimental wind turbines. This illustration also shows relations between firms via spin-off processes and acquisitions. In doing so, this Figure gives further impressions on the similarities and differences between the industry evolution in the US and in Denmark.

Both industries resemble each other in their spin-off dynamics. Spin-off processes in both industries are only based on a few sources. In the US, United Technologies and US Windpower were the parents of four of the five spin-offs. In Denmark, all five spin-offs were based on Riisager and Nordtank. The graph also shows different longevity of spin-offs. Especially Danish spin-offs like Micon, Wincon Wind or Windmaticx survived for a long time, while US spin-offs like Dynergy, Windtech or VAWTPOWER survived only for a few years. An explanation for this uneven longevity lies in their parents. Also the parents of these short-lived spin-offs stayed only a few years in the industry. Additionally, they only managed to build prototypes. In these examples, the spin-off process is not a sign of success of the parent firm, but results from a withdrawal from the industry due to failure to establish a successful product.

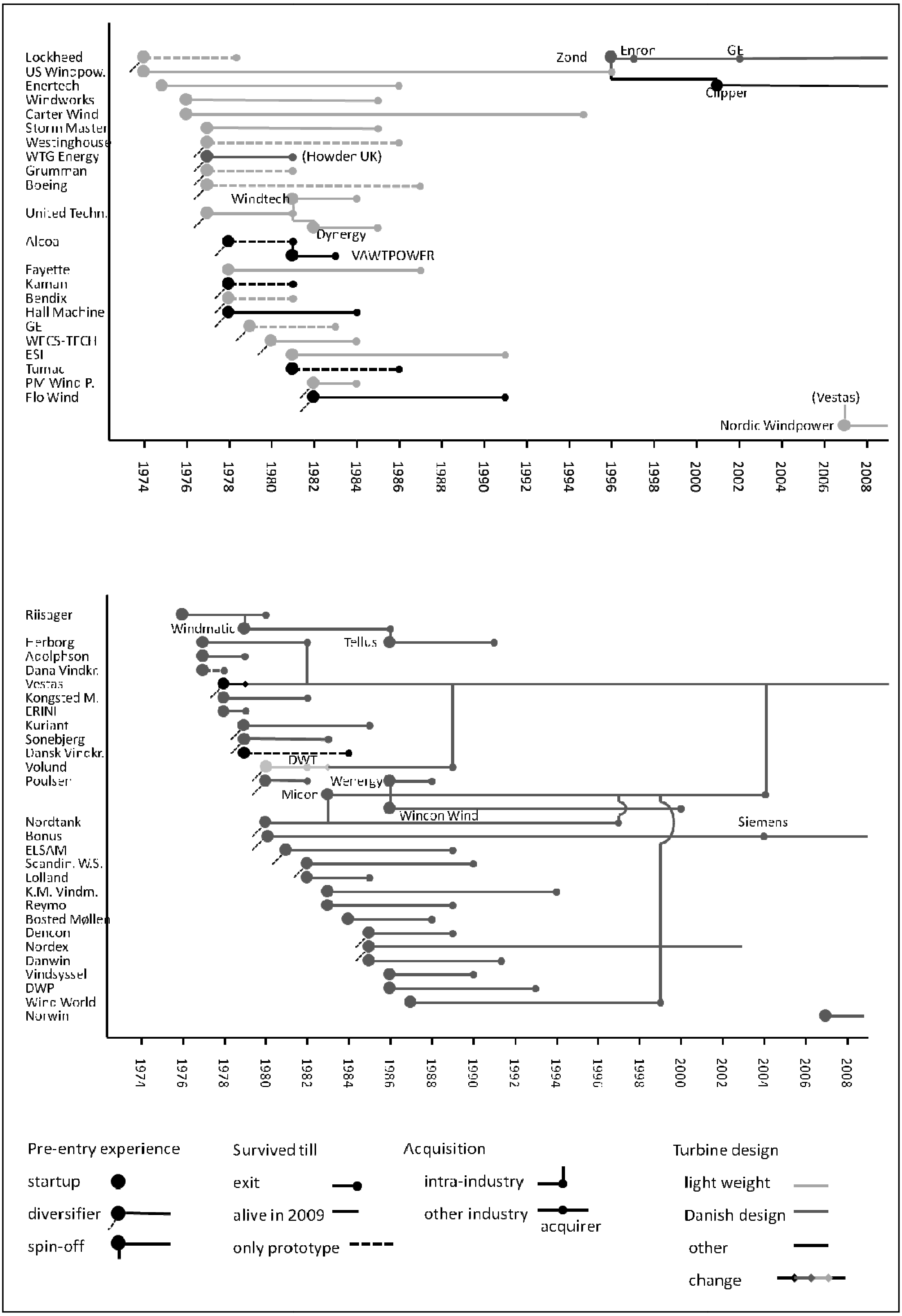

Figure 2: Genealogical development of wind turbine manufacturers in the US and Denmark

The Figure shows no considerable difference regarding acquisitions of wind turbine manufacturers from firms outside the industry. In both industries, larger companies like Siemens or GE entered the industry by acquiring an established manufacturer. Yet, there are differences between the industries regarding intra-industry acquisitions. We could only detect one US manufacturer that was acquired by another wind turbine firm (WTG acquired by Scottish Howden). In Denmark, five manufacturers exited the industry by acquisition from another wind turbine manufacturer. Furthermore, similarly to spin-off processes, acquisitions also took place selectively. Only two firms were responsible for the five acquisitions. Micon acquired two firms, among them its parent Nordtank. Vestas acquired three firms, among them Micon. With Micon, Vestas acquired the remainder of the spin-off line that survived for the longest time. As a result, all acquired firms ended up in Vestas. As the performance of the Danish wind industry was better, this difference supports results by de Vaan et al. (2012) which state that exit by acquisition is a sign of success rather than failure.

The Figure also shows the distribution of light-weight design, Danish designs and other approaches, which is described in Table 5 in more detail. The table indicates the different designs applied in the two countries. Additionally, only few firms deviated from each country's dominant approach. Yet, the applied designs in the US were more diverse than in Denmark.

	US	Denmark	total
light-weight	19	1	20
DK-design	3	28	32
other	6	3	9
total	28	32	60

Table 5: Comparison of applied wind turbine designs ($p < 0.01$)

The research design allows also for changes of designs. Two Danish firms changed their applied wind turbine design. Vestas started with a Darrieus Design and Volund with a version of the light weight design. In the US, changes in the design took place via spin-off processes. Spin-offs like Zond or Nordic Windpower applied other wind turbine designs than their parents US Windpower and the US branch of Vestas.

A fourth interesting difference is the kind of firm that survived at the end. Both industries have three firms which are still alive in 2009. In both industries, two of the three firms have roots in the early development of the industry: In the US, GE and Clipper can trace their roots back to the formation of US Windpower in 1974. In Denmark, Vestas was already formed in 1975 and Siemens is based on the firm Bonus, which was formed in 1980. Both industries had a recent entry in 2007. Yet, while all the US firms still alive in 2009 were spin-offs, two of the three Danish survivors were diversifiers. Also Norwin, the third Danish firm has a distinct history. The firm was a design office for a long time that started to develop and produce wind turbines on its own. As the company has no production experience, we did not assign it as a diversifier.

In contrast to the analysis of the entry pattern in the previous section, which did not indicate differences between the two industries, the analysis of the genealogy revealed three differences that all would support our assumption that Danish firms built up resources in relation to established resources while US firms built up their resource more independent from them. The first is the pattern of acquisitions. In Denmark, the many acquisitions indicate that firms are stronger connected compared to the US, which could facilitate mergers and acquisitions. The fact that all acquisitions ended up in Vestas, the then global market leader, indicates the successful integration of the acquired firms. Second, firms in the two industries dealt differently with technological designs. The larger number of firms following other than dominant technological designs in the US indicates that the ability of LMEs to transfer resources to new fields might allow for higher rates of experimentation. Additionally, design changes took place in both industries, but in different ways. While Danish firms like Vestas and Volund changed designs within the established structure of the firm, examples like Zond, Nordic Windpower and Clipper show that in the US design changes are accompanied by leaving an established firm and built up a new firm. Finally, the survivors of 2009 support our assumption that spin-offs perform better in the US, while diversifiers perform better in Denmark.

Survival Rates

The previous sections described entry patterns and genealogical development of the industries in Denmark and the US. This section will analyze survival rates. Differences are expected regarding country, as the Danish industry performed better than the US industry, as well as regarding the applied technological design, as the Danish design became the standard industry design (Garud and Karnøe 2003). Additionally, the heritage theory of Klepper (2002) would expect higher survival rates for early entrants and for experienced firms compared to inexperienced entries. We expect that the industry in Denmark evolves slower and in stronger connection to established resources and that this particularities affect survival according to entry cohort and firm experience. We would expect a less pronounced difference between entry cohorts in Denmark and a better performance of diversifiers than spin-offs and start-ups compared to the US.

We use Kaplan-Meier graphs for this analysis. Kaplan-Meier graphs describe the percentage of a population that still exists after a given period. Additionally, they show if survival rates remain constant or if the lines intersect. The latter would be a sign indicator might include different dynamics with different influence on firm survival. We found such intersections in our sample. These intersections diminished when we removed those firms that only produced prototypes from our data. Also theory would suggest leaving out these firms. The heritage theory is about production and production experience and not about development of products. Therefore, studies made by Klepper (2002 2007) included only firms that successfully managed a commercial production. We removed 9 US firms and 2 Danish firms from the sample that only produced prototypes. Leaving out these firms additionally required a re-coding of three firms that without a parent could not count as intra-industry spin-off anymore: Dynergy, Windtech and VAWTPOWER. These firms were assigned as start-ups instead.

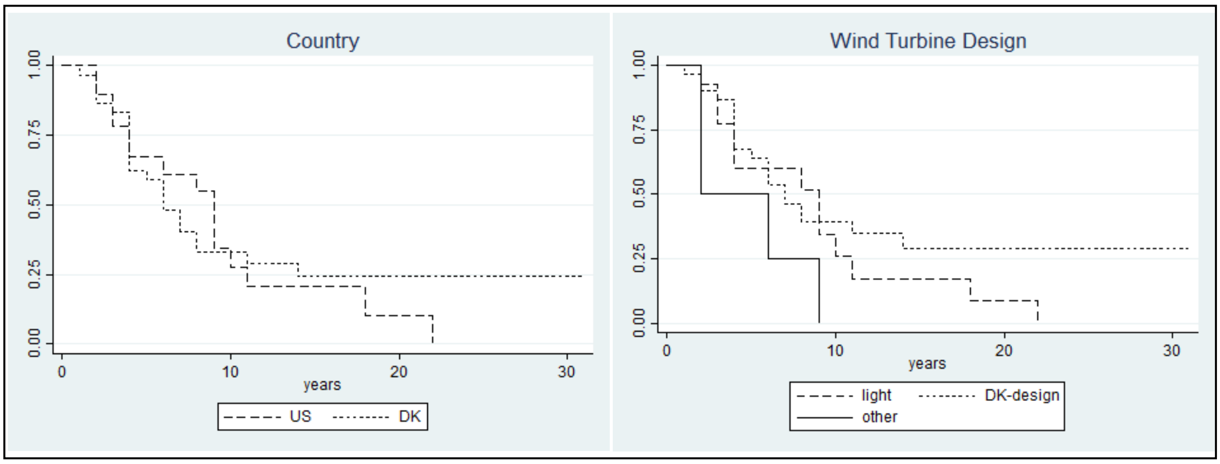

Figure 3: Comparison of survival rates by Country and Wind Turbine Design

Figure 3 shows the survival rates according to Country and Design. Danish firms have a slightly but not significantly higher survival rate than US firms. The wind turbine design shows a more pronounced picture. Firms applying the light-weight design show considerably higher hazard rates than firms applying the Danish design, whereas especially firms producing other wind turbine designs exhibit the lowest survival rates. Yet, due to the few numbers, this difference is not significant (p = 0,14) [14].

[14] We used the logrank test to estimate the p-value, as it still gives meaningful results when many cases are censored.

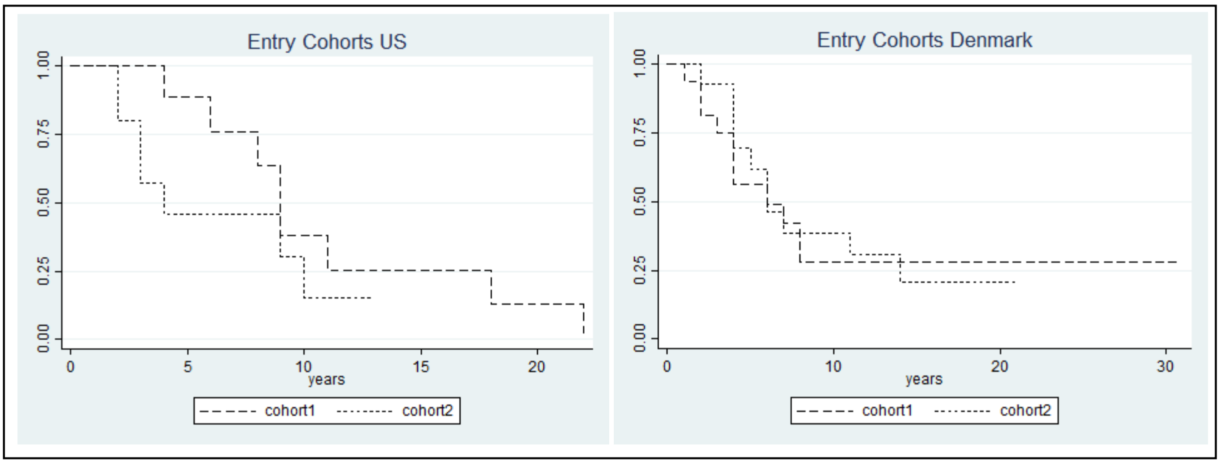

Figure 4: Comparison of between US and Danish Entry Cohorts

Figure 4 describes the survival rates of entry cohorts. We expected that early entrants survive longer than later entrants in the US, while less pronounced differences in Denmark. The Figure shows that entrants in the first cohort show slightly higher survival rates in the US, while it indicates no difference for Denmark. This is a pattern as expected, but not significant.

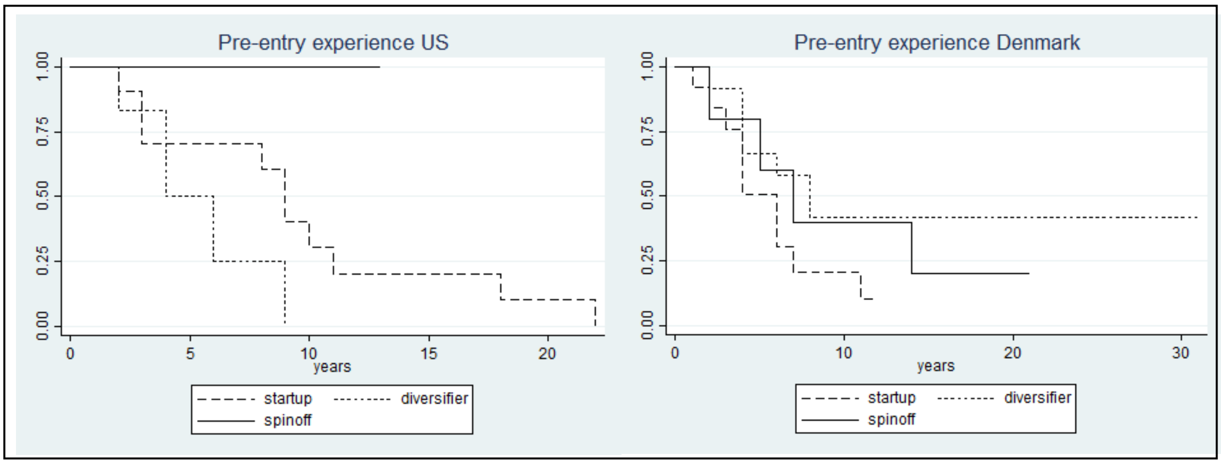

Figure 5: Comparison of survival rates between diversifiers, start-ups and spin-offs in the US and Denmark

Figure 5 describes also the effects of pre-entry experience on survival rate. The Figure shows that spin-offs have the highest survival rate in the US.[15] This pattern is significant to the 10%-level. Additionally, the Figure shows that US start-ups perform better than diversifiers. This

[15] The Figure indicates that none of the US spin-offs exited the industry. Clipper stopped production in 2012, which not included in our data that only go till 2009.

result is at odds with the assumption that diversifiers benefit in the new industry from experiences in their old industry. Yet, this might reflect the fact that diversifiers in the US often had a background in the aviation industry. Qualitative studies show that the relatedness between aerodynamic knowledge in aircrafts and wind turbines was only perceived (Garud and Karnøe 2003), which resulted in high failure rates of these firms. In contrast, startups like US Windpower with a university background performed much better. In contrast to the US, Danish diversifiers with examples like Vestas and Bonus were the best performing category. At all, the patterns indicate different evolutionary dynamics in both industries, which prefer spin-offs in the US and diversifiers in Denmark.

Survival Analysis of US and Danish Wind-turbine Producers

The previous section investigated differences at the industry level. This section moves the perspective to the individual firm to analyse how different types of entries perform in the different institutional environments of the US and Denmark. We expect diversifiers to perform better in Denmark and spinoffs and inexperienced start-ups to perform better in the US. We expect these differences to be more pronounced for later entries.

We use the following variables for the analysis. “Denmark” is a dummy for Danish firms. “Cohort2” is in indicator for firms entering in the second cohort. In contrast to other studies (Bünstorf and Klepper 2009, Klepper 2007, Boschma and Wenting 2007), we use an indicator for the later instead of the early entries, as we are especially interested in the performance of late entries. The entry cohorts for US and Danish firms refer to different years, as depicted in Table 4. The analysis includes dummies for diversifiers, spinoff and start-ups. We left out an indicator for related industries, as different forms of relatedness seemed to be important on the two industries and aggravate a comparison. As control variables we use “Design” if firms apply the Danish design. We focus on the Danish design to simplify the model and as this design became dominant.

	Denmark	Design	2.cohort	diversifier	spinoff
Denmark	1				
Design	0,68***	1			
2.cohort	-0,13	0,1	1		
diversifier	0,17	-0,07	-0,32**	1	
spinoff	0,00	0,34**	0,35**	-0,35**	1

Table 6: Correlation matrix (* p< 0,1; ** p<0.05; *** p<0,001).

Table 6 describes the correlation between the different dependent variables (excluding firms that produced only prototypes). The strong and significant correlation between the technological design a firm applies and the country in which it is located is obvious. Yet, country and design affect firms in different ways. While there is no correlation between being a spin-off and located in Denmark, there is a strong connection between being a spin-off and applying the Danish design. Therefore, we include both variables in the analysis.

We apply a hazard model to analyse the hazard rate at age t, denoted as $h(t)$. We use a Gompertz estimation that allows for different hazard rates as the age the firm increases, which is a regular, known pattern for industries that experienced a shakeout (Cantner et al. 2006). The first part of the model describes how the hazard rate changes with firm age. The second part describes a vector of independent covariates describing pre-entry backgrounds, entry time, the wind turbine design (including design changes) and country:

$$h_j(t) = \exp(\gamma t) \exp(x_j \beta)$$

Firm performance as a dependent variable is measured by survival time, i.e. years of production. Firms that still existed after 2009 or were acquired by other wind turbine manufacturers were right-censored. The performance of these firms 2009 is unclear, as well as whether their acquisition resulted from failure or success. Right-censoring drops the respective firm from the population at risk at these dates, but allows the use of information prior to the censored events. In contrast, if production continued, even under a different name, the acquisition by firms of other industries did not lead to censoring or exit (see also Boschma and Wenting 2007).

Table 7 shows the regression results. The regression is based on the data presented in Figure 3 (excluding prototyping firms). Negative values indicate a decrease in the probability of exit, and thus an increase in the probability of survival in a certain year. The first model analyses firm performance regardless of inter-country differences and only includes a dummy for Danish firms, which would account for general differences in the performance of Danish firms. The coefficients all show the direction expected from the heritage theory (Klepper 2007). Late entries perform worse, while diversifiers and spin-offs perform better than other firms. “Design” has a significant effect. “Denmark” has a positive value, which indicates a lower survival of Danish firms. Combined with the negative coefficient for Danish design, which is mostly applied by Danish firms, this result indicates that especially Danish firms using another than the Danish design have a high risk to exit the industry.

The second model analyses deviations in the performance of firms between US and Danish entries according to different pre-entry experiences and entry time. In doing so, we interact all variables with “Denmark”. We detected a better performance of Danish diversifiers compared to their US counterparts, which is significant, while spin-offs perform worse.[16] This divergent performance of Danish spin-offs and diversifiers compared to their US counterparts was expected from our argumentation. Additionally, we expected that Danish late entries would perform better. Also the Kaplan-Meier graph in Figure 5 would indicate such a result. Indeed, Danish late entries perform worse, even if not significant. It might be that this difference stems from the “design” variable. Applying the Danish design strongly reduces hazard. Of the

[16] As none of the two spin-offs in our sample exited the industry till 2009, the indicators are high and do not give meaningful results. In 2012, US spinoff Clipper stopped production. Including this event would give more meaningful coefficients. Despite the exit of Clipper, Danish spinoffs still would perform worse.

late entering Danish firms, all used the Danish design. Therefore, the better performance of late entering Danish firms in Figure 5 might result from the design they apply, which is disentangled in our model.

The previous model indicated the better performance of Danish diversifiers and worse performance of Danish spin-offs compared to their US counterparts. As we assume a longer time to establish these resources in new industries in CMEs, we also expected this difference to be more pronounced for later entries and Danish diversifiers to benefit longer from resources in other industries compared to their US counterparts. Model 3 accounts for different performances according to entry time by additionally interacting “cohort2” with “diversifier” to account for the performance of late diversifiers and additionally to interact late diversifiers with “Denmark” to account for the relative performance of late entering Danish diversifiers. We did not interact “spinoffs” with “2.cohort”, as only one spin-off in the whole sample formed in the first cohort. None of the values in this model is significant. It therefore gives only a rough indication. However, the model shows that diversifiers generally perform better an late diversifiers worse than early diversifiers, as expected form the heritage theory. However, the model also shows that late entering Danish diversifiers perform relatively better, which is a deviation that we would expect from our argumentation. Yet, the model explains less variance than the previous model that did not consider temporal differences.

In the first three models, we measured the performance of diversifiers and spinoffs against inexperienced startups. The models showed differences in performance between spinoffs and diversifiers in the US and Denmark. These results met our expectations that the institutional environments of CMEs and LMEs differ in the way they support the transfer of resources into new industries, and that this difference emanates to different patterns in firm survival and industry evolution. However, we also made assumptions on the performance of startups. We assumed that startups are less economically embedded in both CMEs and LMEs, but that this disembeddedness is stronger penalized in CMEs than in LMEs.

	1. Model	2. Model	3. Model	4. Model	5. Model	6. Model
cohort2	0,43(0,38)	0,71(0,55)	0,07(0,5)	0,41(0,37)	0,31(0,49)	0,26(0,51)
diversi	-0,47(0,41)	0,15(0,56)	-0,77(0,59)			
spinoff	-0,55(0,60)	-16,38(1391)	-0,76(0,62)			
startup				0,49(0,38)	-0,65(0,55)	0,46(0,59)
design	-1,57(0,8)**	0,49(0,58)	-0,74(0,48)	-1,6(0,78)**	-1,44(0,60)**	-0,3(0,53)
Denmark	1,29(0,8)			1,31(0,78)*		
Denmark * cohort2		0,97(0,78)			-0,39(0,67)	
Denmark * diversi		-1,34(0,79)*				
Denmark * spinoff		15,9(1391)				
cohort2*diversi			1,2(1,05)			
Denmark*cohort2*diversi			-0,91(1,04)			
Denmark*startup					2.93(0,79)**	
cohort2*startup						0,25(0,77)
Denmark*cohort2*startup						-0,35(0,85)
age	0,01	0,02	0,01(0,03)	0,01(0,03)	0,03(0,03)	0,00(0,03)
cons.	-2,23(0,36)***	-2,44***	-2,14(0,36)***	-2,71(0,48)***	-1,89(0,51)***	-2,59(0,62)***
Log Likelihood	-60,12	-57,78	-60,72	-60,12	-58,31	-61,47

Table 7: Survival Analysis (p < 0.1*; p < 0.05**; p < 0.01 ***)

Comparable to models 1 to 3, models 4 to 6 describe the survival rates of startups in relation to the remaining firms, i.e. diversifiers and spinoffs. Model 4 mirrors Model 1. It includes beside “cohort2” for late entries, a dummy “Denmark” for Danish firms and “design” for firms using the Danish Design also variable “startup” for inexperienced startups. As expected, these firms perform worse than other entries, yet not significantly. The other variables show coefficients comparable to Model 1. Model 5 mirrors model 2 and differentiates between Danish and US startups. The model shows that Danish startups perform significantly worse, which meets our assumptions. Model 6 mirrors model 3 and additionally accounts for hazard of late Danish startups. We assumed that especially late entering Danish startups perform worse. Yet, the coefficients are low with high standard errors.

To conclude, we found significant results for our assumptions that Danish diversifiers perform better than US diversifiers and Danish startups perform worse than US startups. We also found some indication that Danish spinoffs perform worse than US startups. However, the results did not meet our assumptions that these differences are more pronounced for later entries.

Conclusion

Klepper’s (1996, 2002) heritage theory explains the evolution of industries by firm-specific factors. We contribute to the strand of literature that expanded on his theory by arguing that institutions also affect the pattern of industry evolution (Lundvall 1992, Hodgson 1998). To assess institutional effects, we applied a VoC perspective to the heritage theory (Hall and Soskice 2001). In contrast to other institutional approaches, the VoC perspective focuses on the individual firm and thus shares its analytical level with the heritage theory.

We argued that the most important difference between LMEs and CMEs regarding the emergence of new industries is how resources are transferred successfully from old industries and accumulated in the new industry. We expected firms in LMEs to transfer resources to the new industry in relative independence from established fields and to benefit when they do not need to consider the requirements of other established fields. We expected firms in CMEs to transfer resources into the new industry in relation to established fields and to benefit from synergies to established fields. Additionally, we expected that the less bounded resource transfer in LMEs result in a faster industry formation.

The heritage-theory framework differs between different forms of entry. We operationalized these different entries as different forms of connections between old and new industry. While diversifiers and entries from related industries exhibit the strongest connection to established industries, startups are more loosely connected to them and spin-offs build upon resources already established in a new industry. Therefore, we assumed differences along three dimensions. We expected firstly that the entry pattern indicates which strategies of resource transfer into the new industries are applied by entrepreneurs and firms; we assumed secondly that the performance of different types of entry shows which forms of resource transfer are supported by the different institutional environments, and we assumed thirdly industry formation as indicator for the speed of resource transfer in different institutional contexts.

As the heritage theory was established using examples of US industries, we used it as a model for LMEs and derived expectations for CMEs. In CMEs, we expected a larger amount of diversifiers and entries from related industries. We expected diversifiers and entries from related industries to perform better than their US counterparts, and other entries to perform worse. Additionally, we expected late-entering diversifiers to perform better in CMEs than in LMEs, reflecting the longer time of industry formation and an accompanying higher degree of dependence on input from already established industries. On the aggregate level, we expected a delayed industry formation in CMEs compared to LMEs.

We tested these assumptions on wind-turbine manufacturers in Denmark and the US. The two countries are assigned to different variants of capitalism, the US as an LME and Denmark as a CME (Kenworthy 2006). Although we had to omit relatedness in our analyses, as the two industries were shaped by different related industries, our analysis shows that both industries exhibited different evolutionary patterns. The US industry evolved mostly as expected according to the heritage theory. The industry was started by diversifiers, with spin-offs entering the industry later (Klepper 2009), and spin-offs performed better than diversifiers. The wind industry in Denmark showed an entry pattern that was comparable to the US industry. Actually, the Danish industry exhibited more spin-offs, while we expected it otherwise. We assume that the larger success of Danish wind turbine producers is responsible for it, as especially successful firms are a source for spin-offs (Klepper 2002). In contrast to entry pattern, Danish firms differed from their US counterparts regarding their performance. Spin-offs and startups performed worse while diversifiers performed better than in the US. These results indicate that firms perform better when connected to established resources in Denmark. In contrast, firms that are less connected to established resources or build upon resources already established in the new industry perform better in the US. Additionally, also the faster industry formation in the US compared to Denmark fits to our assumption that industry evolution in the USA quickly became independent of resources in other industries.

Result from the slower industry formation in Denmark, we expected that the Danish industry is longer connected to other industries and therefore the differences between the performance of US and Danish firms to be more pronounced for later entries. Precisely, we expected later entering diversifiers in Denmark to have a lesser disadvantage than their US counterparts. However, we did not find that this difference is more pronounced when considering entry time.

These results were based on established indicators like inexperienced firms, diversifiers and spinoffs. In addition, we also found that design was an important indicator. The two Danish examples that changed the wind turbine design did so within established firm structures. The two examples of design changes in the US performed the design change via spinning off from their parent firm. These examples also show how resources are accumulated incrementally in Denmark, while resources are easily switched into new fields, but also withdrawn form it in the US.

The wind turbine industries of the US and of Denmark served only as examples for industry evolutions in different types of capitalism. There are several limitations when it comes to deriving generalizations from our approach. First of all, our study only deals with a low number of observations. However, it was important that our assumptions on the institutional settings derived from the VoC literature fits to the institutional setting of the industries of investigation. The debate on the appropriateness of the VoC framework to distinguish between countries (Campbell and Pedersen 2007) indicates a certain probability of a mismatch. Therefore, considering qualitative accounts are necessary to assess if the assignment of a country to a particular type of capitalism is correct. The studies by Karnøe (1999), Garud and Karnøe (2003) and Karnøe and Garud (2012) provided the necessary information for the wind turbine industry to ensure this fit. Without these qualitative studies, there would be no indication if results align or deviate from our expectations due to particular industry dynamics, false assumptions or institutional differences. Due to these possible errors, a well described institutional setting is more important than the number of observations.

The second limitation, which is more severe, lies in the differences of the industry evolution in the US and Denmark. One the one hand, such differences are necessary for measurable effects. Furthermore, differences as forms of relatedness and technological approaches strongly show the institutional embeddedness of an industry. On the other hand, these case specific differences have their own effect on firm survival and make it difficult observe general institutional influences on industry evolution. Also the different overall performance of the two industries affects the result. We did not only compare an industry in one institutional setting with an industry in another institutional setting, but also a successful with a nearly distinct industry.

The third and most important limitation lies in the temporality of the VoC framework. The heritage theory usually analyses historical processes, such as the emergence of the automobile or tire industry (Bünstorf and Klepper 2009), while the VoC covers institutional differences from the 1970s onwards. Our proposed framework is therefore only applicable to younger industries like wind turbine production. Furthermore, comparative studies on biotechnology in Germany and the UK from Lange (2009) and Herrmann (2008) show that especially young and technology oriented industries are able to evade their institutional context. For example, firms in new technologies in CMEs use global labour markets and financial systems as well as institutional differences between countries to evade constraints of the dominant institutional forms in the country they are based. These particularities in the evolution of different institutional systems further aggravate a comparison.

These limitations are mainly caused by the setting of our study. However, we consider our contribution especially as a theoretical one. We present an argument based on the VoC framework of how institutions affect industry evolution. We integrated our assumptions into the well-established framework of heritage theory of Klepper (1996, 2001). In doing so, we connect two broad but disconnected fields of research. The cases of the Danish and US wind turbine producers show that such a connection is feasible, but also the complexities and difficulties involved in this connection. Yet, by making this connection, our framework presents a step further towards comparative analyses of industry evolution in different institutional environments.

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