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The Entrepreneurial State in Action: The Danish Robotics Cluster and the Role of the Public Sector

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Abstract
The question of the role of the state in the creation of competitive clusters and innovation systems has drawn increased attention in recent years. Drawing on Mariana Mazzucato's concept of "the entrepreneurial state," this article investigates the role of the public sector in the development of the Danish robotics cluster, a world-leading cluster for production of industrial robots that has developed after the closing of Maersk's shipyard in the city of Odense. In what ways did public programs and actors contribute to the development of this cluster? In what ways did public programs facilitate entrepreneurs, and when did they function as agents or perhaps even risktakers? To answer these questions, this article tracks three layers of public agency: the local, the national, and the European. This article concludes that there were crucial initiatives at all three levels and that these initiatives were not coordinated, but nevertheless connected by a certain *zeitgeist*—the idea of public institutions taking responsibility for the competitiveness of private companies, an idea that blossomed in the period of high globalization from the late 1980s to the 2000s. In other words, what united the efforts of the public sector was not any master plan but an underlying thought collective that made the workings of "the entrepreneurial state" flexible and fit for the unpredictable nature of innovation. Thus, this article argues that industrial policy did not wither away in the age of neoliberalism but changed its form in an increasing complexity of state-market relations.

Keywords: The entrepreneurial state; Industrial clusters; Robotics Industry; Denmark

Introduction

In 2009, the Danish Maersk Group announced that it would close down its shipyard in the city of Odense.[1] The shipyard, Odense Steel Shipyard (OSS), was the largest privately owned workplace in the region, with more than three thousand employees, and thus the announcement was a significant

[1] Larsen, "Lindø er ikke fortid," 839, 853.

setback for a city that had already experienced a ca. 50 percent decline of jobs in the industrial sector from 2000 to 2012. However, what should have been a typical story of deindustrialization in the age of globalization has, so far, turned out to be a story of industrial rebirth. In response to competition from East Asian shipyards, the management of the Maersk Group had already in the mid-1980s invested heavily in research and development at the shipyard, and from the early 1990s a close cooperation with the local university, Odense University (since 1999 the University of Southern Denmark), had made the shipyard world-leading in the use of robots for shipbuilding and the university a leading center for robotics. Thus, when the closing of the shipyard was announced, new companies in the robotics industry were already emerging, and since then a cluster of globally competitive robotics companies has developed.[2] Along the way, from the early cooperation between the shipyard and the university to the current cluster, public institutions have played a crucial role in this story of industrial rebirth. This article analyzes the development of the Danish robotics cluster from this perspective: the role of public institutions. It argues that industrial policy did not disappear in the age of globalization and neoliberalism, but it did change its form as the fostering of globally competitive clusters came to replace national champions and direct subsidization. We know from existing literature how the two last decades of the twentieth century saw a rise in public policies to promote innovation, entrepreneurship, and public-private partnerships. This article asks how this new kind of industrial policy worked at the microlevel of business development.

In her 2013 book *The Entrepreneurial State*, Mariana Mazzucato made the claim that contemporary economic and political discourse has been too dominated by the idea that governments are just a burden to the dynamism of the private sector: "According to this view, the secret behind an engine of innovation like Silicon Valley lies in its entrepreneurs and venture capitalists."[3] In opposition to this view, she argued that the story of Silicon Valley, and similar examples of competitive industrial clusters, would not have been possible without important steps taken by public actors. In other words, our understanding of innovation and economic growth is guided by a false narrative that lays too much emphasis on the role of private agents and too little emphasis on the many successes of the modern entrepreneurial state, and thus we need to understand that "the State has historically served not just as an administrator and regulator of the wealth creation process, but a key actor in it, and often a more daring one, willing to take the risks that businesses wont."[4] The narrative of the private actor as the key to economic growth has been particularly strong in the United States, and thus it is no coincidence that Mazzucato's debunking of the myth is focused on the (forgotten) role of the state in the great success stories of innovation in American industry.

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[2] Steno, *En klynge, der virker*.
[3] Mazzucato, *The Entrepreneurial State*, 2.
[4] Ibid., 4.

Mazzucato is arguably the most important contemporary scholar to deliver this argument,[5] but she is certainly not the only one, nor the first. Numerous social scientists and economic historians have stressed the importance of the state in economic and industrial development,[6] as well as the differences in this role across time and space. Alexander Gerschenkron famously gave birth to the idea that the role of the state was stronger in countries that needed to catch up with leading countries.[7] Likewise, there is a long-standing tradition of emphasizing the role of the state in theories of capitalism in continental Europe, not least in Germany,[8] and social scientists who are working on contemporary emerging markets have developed concepts such as "state capitalism" and "the developmental state," as well as stressed the complexity of the public-private relationship in contemporary economic development.[9] In regard to European history, the Danish business historian Per Boje has argued that this role of the state has deep roots stretching back, at least in the Danish case, to the mid-eighteenth century.[10] However, most research on the history of European industrial policy has stressed the postwar period as the high tide of industrial policy, although still with important differences from country to country.[11] Thus, it is well-documented how industrial policies in Western Europe from the 1950s to the 1970s were dominated by public ownership in selected industries (most prominently in Italy and France), direct investments in "national champions," and vast subsidization for industries in crisis.[12] This literature has also identified how this paradigm of industrial policy underwent important changes in the later decades of the twentieth century in the age of neoliberalism and globalization. This article tries to understand the mechanisms of this new kind of industrial policy by looking at the role of the public sector in the development of the Danish robotics cluster. This is an example of a successful industrial cluster that developed in a period of deindustrialization, and it is a cluster that at crucial points was supported by public agents and programs. What role did the public sector agents and programs play in this process vis-à-vis market actors? Are there examples of public actors functioning as agents of innovation and risk, and what kinds of risks were taken? Was there an actual entrepreneurial spirit in the public initiatives, and what did it look like?

It is the main argument of this article that there was no coordinated effort on behalf of the state; there was no overall plan to achieve a specific goal. No one was working toward creating a

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[5] See also Mazzucato, *The Value of Everything*.
[6] E.g., Weiss, *America Inc.?*
[7] Gerschenkron, *Economic Backwardness*.
[8] For a textbook example, see Fear, "German Capitalism."
[9] E.g., Musacchio and Lazzarini, *Reinventing State Capitalism*; Aoki, Kim, and Okuno-Fujiwara, *The Role of Government in East Asian Economic Development*; and Thurbon, *Developmental Mindset*. For a theoretical perspective, see Aoki, *Toward a Comparative Institutional Analysis*.
[10] Boje, *Vejen til velstand*.
[11] Foreman-Peck and Federico, *European Industrial Policy*, and Grabas and Nützenadel, *Industrial Policy in Europe after 1945*.
[12] Grabas and Nützenadel, "Industrial Policies in Europe in Historical Perspective."

globally competitive cluster of robotics companies, and no one knew that it would end there. Instead, public sector agents worked independently and with different aims, but also united by what could be described as a "thought collective," in this case the idea that public and private institutions had to cooperate to achieve the common goal of keeping Danish businesses competitive in an increasingly global economy.[13] In that sense, the success of the Danish robotics cluster can also be seen as a success for a certain idea of the entrepreneurial state and of industrial policy, which is the idea that public institutions should work closely together with market actors and use the strengths of both sides to keep the national economy strong.[14] Thus, in a theoretical perspective, this article is a contribution to the argument that the late twentieth century saw a significant rise in the complexities in state-market relations, and the following sections is an attempt to understand this complexity through a specific case.[15]

What is the Danish Robotics Cluster?

The Danish robotics cluster is situated in the city of Odense on the island of Funen. Odense is Denmark's third most populous city with a population of roughly 180,000, while the island of Funen has a population just below 500,000. Since its establishment in 2015, the formal cluster organization—Odense Robotics—has been tasked with organizing, furthering, and representing the cluster.[16] Before the existence of Odense Robotics, the Danish robotics cluster only existed as an "organic" cluster without a formal entity organizing it,[17] though it has to be pointed out that the informal networks between central actors in the cluster were highly developed well before the establishment of Odense Robotics, as many of them had been part of the cluster since the 1990s or the early 2000s and knew one another well.[18]

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[13] Neoliberalism is identified as a "thought collective" in Mirowski and Plehwe, *The Road from Mont Pèlerin*.
[14] This *zeitgeist* is identified as the age of "the competition state" in Pedersen, *Konkurrencestaten*.
[15] For the use of the "complexity" in business history, see Scranton and Fridenson, *Reimagining Business History*, 67–72.
[16] In this article, the use of the term *cluster* is derived from the sources in which the meaning and the use of the term is close to Michael E. Porter's definition as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities." Porter, "Clusters and Competition," 199. Research in business history has shown that the coherence of industrial clusters is often questionable and that the term should be applied with caution. Wilson and Popp, *Industrial Cluster and Regional Business Networks*. That perspective could also be applied to the Danish robotics cluster. In this article, however, the question is the role of the public institutions in fostering the cluster, not the structure or coherence of the cluster itself. For the latter question, see Lamberty, "Den fynske Robotklynge."
[17] The Danish robotics cluster is a heavily regional cluster with 69 percent of Danish robot manufacturers located on Funen in 2017. Region Syddanmark, *Robotter og automatisering. Styrkepositioner, udfordringer og udviklingspotentiale*, 45.
[18] Esben Østergaard (Cofounder of Universal Robots), interview by Julian Lamberty and Tage Koed Madsen, December 5, 2018, Odense; Claus Risager (Former head of the Centre for Robot Technology at the Danish Technological Institute and cofounder of Blue Oceans Robotics), interview by Julian Lamberty, Tage Koed Madsen, and Kristina Vaarst Andersen, November 6, 2018, Odense.

As of January 2018, the Danish robotics cluster is comprised of 133 companies that employ 3,900 people,[19] up from 85 companies with 2,200 employees in 2015.[20] The growth in companies since 2015 is in part due to the admission of already existing companies into the cluster, but it is also due to newly formed startups. Thus, 68 out of the roughly 130 companies in the robotics cluster have been founded after 2009,[21] which suggests the existence of a vibrant entrepreneurial culture. A significant part of the growth in jobs is located either in companies that have recently transitioned from small startups to rapidly growing companies, such as Mobile Industrial Robots ApS, whose staff has expanded from a mere 8 full-time employees in 2015 to 94 full-time employees in 2018,[22] or in older companies such as Jorgensen Engineering A/S, which has grown from 84 to 134 employees in the same time span.[23]

Two commonalities that seem to be characteristic for most of the companies in the cluster are that they are trading business-to-business and that most of them make products that are aimed at covering different niche markets in the field of industrial automation. Nevertheless, the Danish robotics cluster is comprised of a variety of different types of companies of which two groups of companies seem to stand out. The first is a group of companies specializing in providing automation solutions for the food producing industry or the agricultural sector. One example is Sanovo Technology A/S, which produces automated machinery for the industrial processing of eggs.[24] This group accounts for roughly one-third of the jobs in the cluster.[25] Most of the companies in this group were established between the 1960s and the 1980s,[26] and they were quite often founded by engineers educated at the local technical college.[27] In other words, the roots of this part of the cluster go back to the time before the introduction of robots at the shipyard. The other significant group of companies in the cluster has a more recent story going back to the research collaboration between the university and the shipyard in the early 1990s.[28] This group consists of innovation-oriented companies that work within the field of collaborative robotics or closely related sectors of that industry.

It is this second group of companies that has come to define the Danish robotics cluster in recent years because it has established the cluster as the leading center of expertise in collaborative robotics. The company Universal Robots, which is the crown jewel of the cluster, was the first company worldwide to successfully introduce collaborative robots to the market and has remained a leader in this market. The latest statistics from 2017 puts the company's global market share at 71

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[19] Odense Robotics, *Insight Report 2020*, 3.
[20] Odense Robotics, *Leading the Next Industrial Revolution*, 6, 11.
[21] Odense Robotics, *Insight Report 2020*, 9.
[22] Calculations based on data from Danish Central Business Register, www.cvr.dk.
[23] Ibid.
[24] Johansen and Boje, *En dansk nicheproduktion*.
[25] Calculations based on data from Danish Central Business Register, www.cvr.dk.
[26] Ibid.
[27] Lamberty, "Den fynske robotklynge," 36.
[28] Steno, *A Cluster of Success*, 25–29.

percent.[29] Collaborative robots are defined as robots that possess the ability to work side by side with humans on the factory floor without the need for safety fencing. Furthermore, collaborative robots are typically rather small and designed to be flexible and user-friendly,[30] which stands in clear contrast to more traditional industrial robots that are typically large, inflexible, and dangerous for humans to be around. This makes collaborative robotics particularly suited for the automation of production processes in small and medium-sized enterprises (SMEs), as many SMEs produce a variety of products, which emphasizes the need for flexibility in automation technology.[31] This means that, while the market for collaborative robots only amounted to 1 percent of the total market for industrial robots in 2015,[32] the market for collaborative robots is growing fast, increasing sales from 10.947 units in 2017 to 24.643 units in 2019.[33] Universal Robots provides compelling evidence for this trend, as the company has managed to increase its annual revenue from ca. DKK 1.5 million in 2008 to just under DKK 1.5 billion in 2018.[34] It was the success of Universal Robots that garnered international attention and gave the Danish robotics cluster its international reputation. Thus, it is fair to claim that there would be no robotics cluster with international renown on Funen without this company in whose wake other companies and startups have attempted to follow in the years after Universal Robots' commercial breakthrough in the beginning of the 2010s.[35] In fact, the success of Universal Robots garnered so much international attention that it was bought by the American automation company Teradyne in 2015 for $285 million, plus a further earn-out of $65 million if certain commercial targets were met in the following years.[36] In 2018, Teradyne also bought MIR, another prominent company in the cluster, for $272 million.

As the robotics cluster was developed alongside the rise of Universal Robots, this analysis deals only with the role of the public sector in relation to this second group of companies, and the development of the cluster and the role of the public sector is tracked at three levels: the local, the national, and the European.

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[29] Region Syddanmark, *Robotter og automatisering. Udvikling og perspektiver for Fyn*, 4; Syddansk Universitet and Pluss, *Økosystemanalyse afforretningsområdet for robotteknologi i Region Syddanmark*, 9.
[30] Region Syddanmark, *Robotter og automatisering. Styrkepositioner, udfordringer og udviklingspotentiale*, 42.
[31] The founders of Universal Robots initially got the idea for their collaborative robot arm while working on an R&D project named "Flexible robots in small and medium sized enterprises," which outlined those needs among SMEs. Esben Østergaard (Cofounder of Universal Robots), interview by Julian Lamberty and Tage Koed Madsen, December 5, 2018, Odense.
[32] Region Syddanmark, *Robotter og automatisering. Styrkepositioner, udfordringer og udviklingspotentiale*, 42.
[33] Region Syddanmark, *Robotter og automatisering. Udvikling og perspektiver for Fyn*, 5.
[34] Calculations based on data from Danish Central Business Register, www.cvr.dk.
[35] Examples of companies can be found in Steno, *En klynge, der virker*, 88–107.
[36] Steno, *A Cluster of Success*, 64.

The Local Level

The chain of events that would ultimately bring about this cluster began to unfold in the late 1980s at the local level. More specifically, the point of origin for the history of collaborative robotics on Funen can be pinpointed to the year 1988, when Carl Th. Pedersen, the vice-chancellor of the university, took the initiative to arrange two meetings between scientists from the Faculty of Natural Sciences and some local industrial enterprises with the hope of identifying opportunities for joint research projects.[37] It must at this stage be pointed out that all Danish universities are public institutions.

The meetings led to the establishment of a joint research project within the field of robotics between the university and the shipyard, as the shipyard was looking to develop robotics solutions for welding processes to improve its international competitiveness.[38] The joint research program was named AMROSE and came under the leadership of mathematics professor John Perram whose research in computer modelling was the scientific foundation of the project.[39] The AMROSE project progressed according to the plan and the robotics technology was deemed ready for the marketplace after six years of research and development. This resulted in the establishment of the spin-out company AMROSE A/S in 1996.[40] It marked the first instance of commercialization based on the robotics research conducted at the university and must therefore be regarded as the point of origin for the establishment of a commercial robotics cluster on Funen, interestingly with the university as a co-owner alongside scientists and the shipyard. The site for this cooperation was the local science park that was established in the years around 1990, at the initiative of the university and with the purpose of furthering cooperation between researchers and local businesses. In the process behind the creation of the science park, and in other reach-outs to the local business community in this period, there are many examples of university executives arguing that cooperation with the university was crucial for innovation in the private sector. In a local paper, for instance, the vice-chancellor argued that this was the key if the region should not be left behind in coming waves of innovation as it had been in the most previous waves of biological and medical innovation.[41]

The AMROSE project proved a success for both the university and the shipyard, which in 1997 had about two hundred people working on different R&D projects. About fifty of these people were employed at the shipyard's R&D department, while the rest were formally employed by external partners.[42] Therefore, the representatives on both sides agreed that it would be worthwhile exploring whether it was possible to establish more permanent research capabilities within the field

[37] Perram, "Lindø Center for Anvendt Matematik," 53–54.
[38] Christensen, "Skibsbygning og værftsanlæg," 734–738.
[39] Steno, *En klynge, der virker*, 25–27.
[40] Perram, "Lindø Center for Anvendt Matematik," 53.
[41] Nevers, "Odense som universitetsby," 153–156.
[42] Christensen, "Optakten til robotklyngen," 103-104.

of robotics at the university. They decided to approach the Maersk Group with a request for funding of a permanent robotics department at the university. The negotiations between the university and Maersk were difficult, but in the end the foundation behind the company agreed to donate DKK 75 million to the establishment of a full department if the university was willing to spend an equal amount of its own funds.[43] This constituted—at that time—the largest single donation ever given to a Danish university by a private organization.

The establishment of the Mærsk-McKinney Møller Institute for Production Technology—as the department was named—would prove to be a crucial event for the subsequent development of the robotics cluster, as it established a permanent hub for research and education that has continuously provided the robotics industry on Funen with highly skilled graduates, and it is still at the forefront of international robotics research, particularly within the field of collaborative robotics. Thus, the university's role in laying the foundation for the development of the cluster is significant, and it is worth mentioning that senior university executives and the scientists who pushed for this collaboration with the private sector were confronting resistance within the university.[44] This type of close cooperation with a private company was, at this time, unusual for a Danish university, which was neither a technical university nor a business school, which have historically had closer ties to the private sector than traditional universities. This indicates an entrepreneurial spirit in the university leadership. They certainly ran the risk of upsetting the traditional culture at the university by establishing a close cooperation with a private company, even going as far as becoming co-owner of AMROSE A/S. Although the university's willingness to cooperate with the shipyard fits the overarching argument that public sector agents have since the 1990s to an increasing degree put emphasis on—the idea that public and private institutions have to cooperate in order to achieve the common goal of keeping Danish businesses competitive in an increasingly global economy—it is also important to point out that these public sector agents also had other motivations for engaging in these types of activities. In the case of the university's cooperation with the shipyard, it is clear the university leadership also expanded its engagement in robotics because it benefitted the university itself in the form of potential research funding.

Thus, the 1990s was a period in which the expertise within robotics grew quickly, although it is too early to speak of an actual cluster at this point. This changed markedly in the beginning of the 2000s as the robotics environment experienced a crisis, which was brought about by coinciding events. On the local level, the shipyard decided to abandon its interest in robotics research. This change in strategy was caused by the realization that the shipyard would not be able to stay competitive in the long run.[45] This also brought about the dissolution of AMROSE A/S, as the

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[43] Mærsk McKinney Møller, "Document," 7.1.1997. ESDH Jour. Nr. 031/300-2, akt. nr. 1.
[44] John Perram (Former professor of Applied Mathematics at the University of Southern Denmark), interview by Julian Lamberty and Jeppe Nevers, June 3, 2019, Odense; Jens Oddershede (Former rector of the University of Southern Denmark), interview by Julian Lamberty and Jeppe Nevers, December 4, 2017, Odense.
[45] Steno, *A Cluster of Success*, 31.

company lost its only significant customer.[46] On a broader international scale, businesses focused primarily on the outsourcing of production capabilities to low-wage countries instead, as this was at the time a more economically viable strategy than investing in automation of production facilities.[47]

Up until this point, local and regional governmental actors had not been engaged in the robotics environment, but as the future of the robotics environment was now in danger of disappearing, the municipality of Odense and the county of Funen decided to support it more actively. This change of policy took place while the concept of "industrial clusters" began to work its way into Danish policy discourse and also informed the discourse on industrial policies at the local level. For instance, a report from 2002, commissioned by the municipality of Odense, outlined a strategy for the city's industrial policy that would more actively engage the municipality as a "bridge builder" between local businesses, the higher education sector, and the city itself.[48] Furthermore, the report recommended that the municipality focus its industrial policy on supporting four sectors that were to act as locomotives for the development of the local business community. One of these sectors was the local "Metal- and Production Technology,"[49] which became a point of focus because the fabrication of industrial production technology had traditionally been a position of strength for the local business community.[50] Furthermore, the report pointed out that there had been a considerable buildup of know-how in related fields in the local educational sector, particularly at the Mærsk Institute at the university, which was identified as an "apt promotor and driving force in regard to the central challenge of bridge building between the existing more traditional competencies within the field of production technology and [new] IT [capabilities]."[51] Thus, the aim of the policy was to create "a competitive and high-tech cluster within the field of production technology."[52] The mayors of the county of Funen and the municipality of Odense saw these investments as a help "to start up the development process in all four areas and as a contribution to the coordination of this joint effort." However, they were aware that "funds of a completely different scale must be raised in the form of private risk capital in order to create growth in the dynamic companies and to help young entrepreneurs, which are coming forward in the region."[53] In other words, they viewed their investments as an aid that could help the robotics environment to develop in order to attract capital, which it neither could or should replace.

This more active approach taken by the municipality and the county of Fyn resulted in the establishment of Robocluster in the fall of 2002, founded as an independent "growth environment," located at the Mærsk Institute and funded by local educational institutions, the Danish Ministry of

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[46] Ibid., 31.
[47] Ibid., 32.
[48] PLS Rambøll Management A/S, *Odense som brobygger*.
[49] Ibid., 2.
[50] Ibid., 28.
[51] Ibid., 29.
[52] Ibid., 27.
[53] Jan Boye, Anker Boye, and Finn Brunse, "Visioner og vækst," Fyens Stiftstidende, April 15. 2002.

Science, as well as the county and municipality.[54] The purpose of Robocluster was to cut across the public-private sector divide and act as a hub for the robotics environment to promote networking and to facilitate knowledge accumulation.[55] Robocluster would, in the coming years—along with the Mærsk Institute and the local branch of the Danish Technological Institute—play an important role in the development of the cluster, as these institutions managed to obtain research funding from the EU as well as from Danish funding bodies. Claus Risager, then the head of the robotics department within the Danish Technological Institute, describes how and why he and Rune K. Larsen, then head of Rococluster, consciously decided to focus their efforts on acquiring public funding in the early 2000s: "We [the Danish Technological Institute and Robocluster] had to start over. And what did we do? We began to apply for money from public foundations. That was what we decided to do, because all the private companies were very sceptic."[56] Therefore, public funds proved crucial for upholding the local robotics environment in the early 2000s, and the people in charge of the cluster organizations were keenly aware of it.[57] The municipality of Odense upheld its supportive policies in its revised industrial policy strategy of 2007, which more clearly focused its efforts on the robotics sector.[58]

In the years following the publication of this strategy, the cluster experienced its big commercial breakthrough initiated by the success of Universal Robots in the early 2010s. This success further intensified support from local governmental actors, particularly because the number of jobs in the industrial sector was in rapid decline at this point. The closing of the shipyard was announced in 2009, and production finally ended in 2012.[59] Meanwhile, the municipality of Odense had experienced a ca. 50 percent decline of jobs in the industrial sector in the period 2000–2012. This meant that the municipality was highly motivated to promote a new narrative of success relating to a part of the local industrial sector (i.e., the robotics sector) and that it was willing to commit significant resources to further the development of the cluster.

This increased commitment later led to the founding of the organization Invest in Odense in 2014, an entity within the Mayor's Department.[60] One of Invest in Odense's tasks was to provide funding for the formal cluster organization of the robotics industry, Odense Robotics, which was established in 2015. The task of funding Odense Robotics was shared between Invest in Odense and another recently formed local organization, Developing Fyn,[61] which was a cooperation between

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[54] "Historie," Robocluster, accessed September 25, 2020, https://robocluster.dk/om-robocluster/roboclusters-historie/.
[55] Ibid.
[56] Claus Risager (Former head of the Centre for Robot Technology at the Danish Technological Institute and cofounder of Blue Oceans Robotics), interview by Julian Lamberty, Tage Koed Madsen, and Kristina Vaarst Andersen, November 6, 2018, Odense.
[57] Steno, *A Cluster of Success*, 34–35.
[58] Odense Kommune, *Erhvervs- og vækstpolitik*, 50.
[59] Larsen, "Lindø er ikke fortid," 839, 853.
[60] "About Invest in Odense," Invest in Odense, accessed June 9, 2018, http://investinodense.dk/about-invest-in-odense/.
[61] "About Odense Robotics," Odense Robotics, accessed June 10, 2018, https://www.odenserobotics.dk/about-odense-robotics/.

five local municipalities on Funen, tasked with furthering the development of selected business areas, one of them the robotics sector.[62] Odense Robotics is therefore not a private organization springing from the local robotics industry, but rather a policy initiative created and funded by local governmental actors and established with the purpose of promoting, furthering, and organizing the local robotics industry. Whereas private enterprises and expertise within the field of robotics had developed significantly in the preceding years, it was not until the establishment of Odense Robotics that the notion of a robotics cluster on Funen experienced a real breakthrough. This breakthrough can be demonstrated by counting the number of articles in the local newspaper, *Fyens Stiftstidende*, which referenced the phrase "robotics cluster." From 2002 to 2014, only eleven articles contained this phrase, a number that rose to ninety-nine articles in the period 2015–2017[63] (i.e., the period following the establishment of Odense Robotics). Odense Robotics has, in other words, been the central agent behind the creation of the narrative of a successful robotics business cluster in the region, a narrative that has significantly increased the local awareness of the cluster and walked hand in hand with several large investments from local sources.

Another important initiative organized by Odense Robotics was the creation of a so-called StartUp Hub, which can be described as an incubator for innovative startups. Its activities include a wide variety of tasks aimed at supporting startup enterprises in everything from product development, business plans, and strategies, to assisting in the task of acquiring venture capital, and all this is free of charge if a company is admitted into the hub.[64]

In short, the industrial policies of the municipality and other local political actors underwent a significant change at the turn of the millennium, from nonengagement to policies that supported the sector in a variety of ways. On the one hand, there are industrial policies in which these local actors take a facilitating role. They have, however, also launched some initiatives that more directly put them in the role of active agents of innovation, as in the case with the StartUp Hub, where the municipality of Odense invests its resources in furthering the early development of selected startup companies to ensure a steady stream of new innovative companies for the cluster.

Apart from these political actors, the university has also increased its commitment to education and research in the field in recent years. Most recently, it has committed DKK 100 million to a project titled Industri 4.0, aimed at a further strengthening of its research in robotics,[65] and in 2017 it established a new education program providing graduates in robot technology.[66] This was done to combat the shortage of qualified labor for the cluster,[67] which in a recent report was

[62] "About Us," Developing Fyn, accessed June 10, 2018, https://www.udviklingfyn.dk/about-us.
[63] Calculations based on data from www.infomedia.dk.
[64] "StartUp Hub," Odense Robotics, accessed June 10, 2018, https://www.odenserobotics.dk/startup-hub/.
[65] "SDU investerer 100 millioner i Industri 4.0," Syddansk Universitet, accessed June 12, 2018, https://www.sdu.dk/da/aktuelt/nyt_fra_sdu/100_millioner_til_industri_4_0.
[66] "SDU skal uddanne de første diplomingeniører i robotteknologi," Odense Robotics, accessed June 11, 2018, https://www.odenserobotics.dk/sdu-skal-uddanne-de-forste-diplomingeniorer-i-robotteknologi/.
[67] Ibid.

deemed to be one of the most significant weaknesses of the cluster that could threaten its successful development in the future.[68] Although not directly related to the development of the robotics cluster per se, the university also increased its commitment to teaching entrepreneurship to its students. Thus, although 1,265 students at the university followed entrepreneurship courses in 2010,[69] this number had risen to over 2,500 in 2014.[70] In other words, creating entrepreneurs played an increasingly important role in the university's agenda. Prompted by legislative changes on the national level of policy making,[71] the university also opened a patent office in 2003[72] with the aim of furthering the commercialization of inventions. This initiative was not always to the liking of its researchers and students, who were attempting to become entrepreneurs and who felt that this, at times, hindered their own opportunities.[73]

This trend, of the university acting as forging a kind of entrepreneurial spirit, continued in the mid-2000s, and it was again prompted by legislation at the national level that now allowed Danish universities to establish an investment company, which it could use to invest a maximum of DKK 5 million per company in innovative startups,[74] primarily based on research conducted at the university itself. This led to the establishment of Science Ventures Denmark A/S in 2005.[75] Since its establishment, Science Ventures Denmark A/S has invested in a number of companies that are or have been part of the Danish robotics cluster: Universal Robots A/S, Smooth Robotics ApS, Enabled Robotics ApS, and CP Robotics ApS.[76] Furthermore, Science Ventures Denmark A/S became co-owner of Syddansk Innovation in 2007.[77] Although formally a private company, Syddansk Innovation was—until the structure of the Danish innovation system was changed in 2019—one of Denmarks officially recognized "innovation environments" funded by the state. It is tasked with investing in the earliest stage of business development of innovative startups—when the risk factor is generally much too high for private investors—and can invest up to DKK 6 million per startup.[78] Like Science Ventures Denmark, Syddansk Innovation has also invested in several

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[68] Syddansk Universitet and Pluss, *Økosystemanalyse*, 51.
[69] Fonden for Entreprenørskab–Young Enterprise, *Entreprenørskab fra ABC til ph.d.* (2010), 83.
[70] Fonden for Entreprenørskab–Young Enterprise, *Entreprenørskab fra ABC til ph.d.* (2014), 91.
[71] A new law ratified by the Danish Parliament in May of 1999—aimed at furthering the commercialization of inventions at Danish universities—allowed universities to hold the rights to inventions springing from the work of its employees, if it wished to do so. Folketinget, "L93 Lov om opfindelser ved offentlige forskningsinstitutioner," in *Folketingstidende 1998/99, Tillæg C*, accessed June 15, 2019, http://webarkiv.ft.dk/?/samling/19981/menu/00000002.htm.
[72] Lamberty, *Universitetet og konkurrencestaten*, 255.
[73] Esben Østergaard (Cofounder of Universal Robots), interview by Julian Lamberty and Tage Koed Madsen, December 5, 2018, Odense.
[74] Folketinget, "L177 Lov om teknologioverførsel m.v. ved offentlige forskningsinstitutioner," in *Folketingstidende 2003/04, Tillæg C*, accessed June 15, 2019, http://webarkiv.ft.dk/?/samling/20031/menu/00000002.htm.
[75] Lamberty, *Universitetet og konkurrencestaten*, 255.
[76] "Portefølje," Science Ventures Denmark, accessed June 23, 2019, www.scienceventures.dk/da/portefølje/.
[77] PricewaterhouseCoopers, "Science Ventures Denmark A/S. Årsrapport for 2007," Danish Central Business Register.
[78] "Vi investerer risikovillig kapital i innovative idéer," Syddansk Innovation, accessed June 23, 2019, www.syddanskinnovation.dk/om-sdi/.

companies that either have been or are still part of the Danish robotics cluster: CP Robotics ApS, Effimat Storage Technology A/S, LapTics IVS, Smooth Robotics ApS, Farm Droid ApS, Lorenz Technology ApS, etc.[79] Although the funding for Syddansk Innovation's investments come from the state, the university is, via Science Ventures Denmark's co-ownership, involved in the running of Syddansk Innovation and therefore has some influence on how the innovation environment invests it money. Generally, as its freedom to interact in this area increased, the university seized the opportunity to become more actively involved in furthering the commercialization of research and inventions, thereby not only acting in a facilitating role, but at times also directly investing into robotics companies such as Universal Robots.

Lastly, the increased interest in the robotics cluster in recent years, after the birth of the "success narrative," is also apparent in the fact that Odense Robotics, the Region of Southern Denmark,[80] and the university have all published reports on robotics industry in the region.[81] All these initiatives demonstrate that local public actors have put significant resources into the development of the cluster to ensure that the potential that the cluster holds for regional development and job creation is not squandered. In other words, public actors at the local level have played a significant role in the development of the Danish robotics cluster, and it seems reasonable to describe these developments as a story of rising complexities in state-market relations. The university has been a key local agent throughout the process, whereas the municipality and other local actors began to act only from the turn of the century. There was no common plan behind these activities, but it is certainly possible to identify a common underlying belief in the importance of public-private partnerships for securing competitiveness in local businesses alongside different institutional interests.

The National Level

An early example of changes at the national level that later came to have an impact on the development of the Danish robotics cluster was the profound change of Danish university politics from the early 1970s to the early 2000s. During this period, Danish university politics transformed from a discourse of social mobility to a discourse based on the idea that research and higher education is the key to economic growth and development, thereby more directly tasking Danish universities with improving the competitiveness of the private sector.[82] These changes must be taken into consideration when assessing the motives behind the decision of Vice-Chancellor Pedersen to arrange meetings between scientists and local businesses in the late 1980s.

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[79] "Virksomhederne," Syddansk Innovation, accessed June 23, 2019, www.syddanskinnovation.dk/portefoljeselskaber/.
[80] The Region of Southern Denmark replaced the County of Funen as a regional governmental body in 2007.
[81] Odense Robotics, *Leading the Next Industrial Revolution*; Region Syddanmark, *Robotter og automatisering. Styrkepositioner, udfordringer og udviklingspotentiale*; Syddansk Universitet and Pluss, *Økosystemanalyse*.
[82] Lamberty, *Universitetet og konkurrencestaten*, 267.

Another important development on the national level of policy making was that the concept of "industrial clusters" became a focal point of Danish industrial policy in the early 2000s, when the Danish Agency for Trade and Industry under the Ministry of Commerce published two reports that focused on identifying so-called competence clusters.[83] These initiatives came out of a strong state trend in the 1990s toward identifying national "business strongholds," a trend that was inspired by the theories of Michael E. Porter.[84] The 1991 annual report stated, for instance, that "globalization and closer European cooperation does not make Danish industrial policy irrelevant. It is up to ourselves to establish good general circumstances and to develop the areas of resources that can lead to growth in the private sector."[85] However, none of these reports from the 1990s or the early 2000s identified a robotics cluster or an automation cluster on Funen, which indicates that the activities at this point had not yet reached a scale, structure, and coherence that allowed them to live up to the criteria that were requisite for qualifying them as clusters. Nevertheless, the reports show that the Danish government began to give the concept of business clusters a prominent place in its industrial policy.

Another example of national policy making that would prove to have a different and much more direct effect on the development of the cluster was the establishment of the Danish Growth Fund in 1992.[86] The purpose of the fund was to further and support industrial development in Denmark, especially SMEs,[87] as these were perceived to be lacking the funds necessary to undertake the R&D projects that were crucial for sustaining competitiveness in the increasingly internationalized marketplace.[88] The Danish Growth Fund was established as an independent body governed by a board of directors chosen by the minister of commerce and was given an endowment of DKK 2 billion, which it could use for loans, subsidies, or guaranties to companies that undertook such development projects.[89] The fund, though, was initially not to invest its capital directly in companies to become a shareholder, as this type of activity was deemed to be the domain of private investors.[90] However, this changed in 2001, when the Danish Parliament passed a new law for the operation of the fund[91] that was now allowed to invest directly in companies,[92] thereby effectively turning it into a governmental venture fund. The hope was that this would provide the fund with the tools to support the development of Danish businesses in a more efficient way, as well as the

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[83] Erhvervsfremmestyrelsen, *Kompetenceklynger i dansk erhvervsliv*; Erhvervs- og boligstyrelsen, *De danske kompetenceklynger*.
[84] Nevers, "Fra fabrikker til innovationsklynger."
[85] Industriministeriet, *Erhvervspolitiskredegørelse 1991: EFserhvervspolitik*, 9.
[86] Folketinget, "Lov om Dansk Erhvervsudviklingsfond," in *Folketingstidende 1991/92, Tillæg C*, sp. 289–292.
[87] Ibid., sp. 289.
[88] Folketinget, "Lov om Dansk Erhvervsudviklingsfond," in *Folketingstidende 1991/92, Bind 1*, Sp. 1725–26.
[89] Folketinget, "Lov om Dansk Erhvervsudviklingsfond," in *Folketingstidende 1991/92, Tillæg C*, sp. 289–290.
[90] Folketinget, "Lov om Dansk Erhvervsudviklingsfond," in *Folketingstidende 1991/92, Bind 1*, Sp. 1727.
[91] Folketinget, "L62 Lov om ændring af lov om Vækst Fonden og ligningsloven," in *Folketingstidende 2000/01, Tillæg C*, accessed June 15, 2018, http://webarkiv.ft.dk/?/samling/20001/menu/00000002.htm.
[92] Ibid.

opportunity of reaping significant economic benefits if it invested its funds successfully.[93] To the question of why the state needed to get involved in the venture business, the director of the Growth Fund, Christian Motzfeldt, had a clear answer: "Nobody else is doing it. There is a glaring lack of capital to develop Danish growth companies. The Danish Growth Fund has been created to stimulate this market and act a lever for many companies. But our two billion kroner cannot lift it all, as there is a need for an amount in the double-digit billion range."[94] Like the mayors of the county of Funen and the municipality of Odense, Motzfeldt was aware that the Growth Fund could not replace private capital, but unlike the former public initiatives, the Growth Fund now invested directly in private companies on the same conditions as private capital, thereby erasing the older lines between public and private actors. This realignment of the Growth Fund's activities would prove to be crucial to the development of the Danish robotics cluster some years later.

As stated in the description of the robotics cluster above, Universal Robots is today the crown jewel of the cluster, and it was also crucial in the robotics cluster's early formation, as it became the first commercial success and put the cluster on the map internationally as a leader within the field of collaborative robotics. This, however, was not yet the case in 2008, when the company was on the verge of going bankrupt. The company had been founded by three junior researchers at the university in 2005 and had then obtained DKK 1.2 million in startup capital from the public institution Syddansk Innovation.[95] The following years were spent developing the company's collaborative robotic arm, and by the end of 2007 all funds had been spent.[96]

Although the product was far along in its development, Universal Robots nevertheless found it impossible to acquire further capital from private investors, because the market for collaborative robotics was uncharted territory at the time. In this situation, the Growth Fund stepped in and invested DKK 7.65 million in Universal Robots, while Syddansk Innovation agreed to invest another DKK 1.9 million.[97] These investments effectively saved the company from bankruptcy according to Esben Østergaard, one of the entrepreneurs who founded Universal Robots.[98] Funding was, however, not the only important asset that the fund injected into the company. The founders of Universal Robots all had a background in the research environment at the university, but none of them had experience in how to run a company.[9999] The Growth Fund, therefore, insisted that Universal Robots hire a new CEO with extensive management experience, and this led to the hiring of Enrico Krog Iversen. Iversen saw that the company's robotic arm had great promise, but that the

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[93] Steno, *Hvor markedet tøver*, 59.
[94] Ole Andersen, "Arkitekten bag fonden: Skrigende mangel på kapital," *Berlingske Tidende*, May 10, 2007, 4.
[95] Steno, *A Cluster of Success*, 41.
[96] Ibid., 44–45.
[97] Ibid., 51.
[98] Esben Østergaard (Cofounder of Universal Robots), interview by Julian Lamberty and Tage Koed Madsen, December 5, 2018, Odense; Clas Nylandsted Andersen (Former chairman of the board at Universal Robots), interview by Julian Lamberty and Jeppe Nevers, November 7, 2017, Odense.
[99] CVs of the three founders of Universal Robots A/S are available at www.linkedin.com.

company's strategy had to be changed if it was to maximize its potential. Previously, Universal Robots had not only developed and sold their robotic arm, but also provided technical consultancy to its customers to ensure that their products worked according to the specific needs of each customer. Iversen realized that this put limits on the scalability and growth potential of the company. He therefore decided that Universal Robots should focus solely on providing a robotic arm, while aggressively increasing its sales revenues via a network of global third-party distributers that would take over the tasks of sales and consultancy, thereby allowing the company to increase its sales rate more rapidly.[100]

Iversen's strategy proved correct, as Universal Robots' turnover increased manifold in the coming years, from DKK 1.575 million in 2008 to over DKK 403 million in 2015 when the company was acquired by the American company Teradyne.[101] In other words, the Growth Fund played a crucial role in the development of the cluster because Universal Robots—without which there would be no Danish robotics cluster of international renown—would have gone bankrupt instead of becoming the world leader. The Growth Fund thereby exemplifies an instance in which the Danish state, on a national level of policy making, acted as an agent of innovation and risk, as it acted like a venture fund and invested directly into a company. It thereby assumed all the financial risks that such an investment encompasses, a risk that no private investors at that time were willing to take. Furthermore, the example of Universal Robots demonstrates how the Danish state had developed a two-pronged system for investing directly into innovative private companies. One the one hand, there were the Danish "innovation environments," here exemplified by Syddansk Innovation. These were first created in 1998 with the aim of providing funding and support for the early phases of startups, and they could make an initial investment of DKK 3.5 million and then later add another DKK 2.5 million if private investors contributed at least 60 percent of the funds in this second investment round.[102] On the other hand, there was now also the Danish Growth Fund, which could also invest in startup companies but with higher amounts, making it more suited for investments in later phases of business developments when more capital is typically required. The Growth Fund later invested in two other companies that are part of the Danish robotics cluster. These companies are Kubo Robotics Aps and Onrobot A/S.[103]

Two other policy initiatives must be covered to show the full spectrum of governmental policy making at the national level. Both initiatives were directly inspired by EU policies. The first example is the initiative taken by the Danish government in 2006 to create the so-called Globalization Strategy, which was developed with the aim of creating world-class education,

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[100] This section draws on Steno, *A Cluster of Success*, 45–48.
[101] Calculations based on data from Danish Central Business Register, www.cvr.dk.
[102] Forsknings- og Uddannelsesministeriet, Styrelsen for Institutioner og Uddannelsesstøtte, *Performanceregnskab for innovationsmiljøerne 2017*, 5.
[103] "Virksomheder vi har finansieret," Vækstfonden, accessed June 23, 2019, https://vf.dk/cases/.

innovative research, and increased numbers of Danish entrepreneurs.[104] This agenda entailed the establishment of the so-called Globalization Fund that was entrusted with a massive DKK 43 billion endowment, which it proceeded to distribute for various causes and initiatives within the fields of research, education, and innovation during the period from 2007 to 2012.[105] This entailed a massive influx of funds into R&D, and it was a highly favorable program for the robotics industry on Funen.

The other initiative is the creation of a national cluster strategy in Denmark in 2013, which generally aimed at coordinating the many national and local activities within the field of cluster-related policy making. The three main initiatives in the strategy were (1) the creation of a cluster forum for coordinating cluster policies and activities in Denmark; (2) the implementation of activities aimed at improving and professionalizing Danish cluster organizations; and (3) an effort to strengthen the international activities of Danish clusters.[106] The goal of establishing a cluster forum subsequently also resulted in the establishment of Cluster Excellence Denmark, which is a publicly funded national organization tasked with supporting the development of Danish cluster organizations, so that these may in turn become better service providers for their members.[107] This cluster strategy was updated for the period 2016–2018, which did not alter the strategy significantly, but heightened the level of ambition by striving to ensure that Denmark possessed a group of business clusters in the international elite.[108] This increasing coordination of Danish cluster policies in recent years demonstrates that the concept of the business cluster is becoming an increasingly more important part of Danish industrial policy and has therefore undoubtedly affected the development of the Danish robotics cluster by facilitating the development of its formal cluster organization, Odense Robotics. Furthermore, the formation of a national cluster strategy lends itself to the interpretation that it was not only created in response to EU policies in this field, but also represents the natural continuation of a Danish cluster policy that reaches back to the beginning of the 2000s, when the Danish government launched its first attempts at identifying business (competence) clusters in the Danish private sector. Like most of the policy initiatives on the national level, the Globalization Strategy and the national cluster strategy put the Danish State in a role of framing and facilitating agent in relation to the development of the Danish robotics cluster, as these types of policies generally have a wider aim than specifically supporting this cluster. However, the creation of the two-pronged system consisting of "innovation environments" and the Danish Growth Fund has demonstrated that the Danish state was increasingly willing to make direct

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[104] Regeringen, *Fremgang, fornyelse og tryghed: Strategi for Danmark i den globale økonomi*.
[105] DEA, *Rapport: Globaliseringspuljen 2007–2012. En kortlægning af fordelingen*.
[106] Ministeriet for Forskning, Innovation og Videregående Uddannelser, *Strategi for samarbejde om Danmarks klynge- og netværksindsats*.
[107] "Om Cluster Excellence Denmark," Cluster Excellence Denmark, accessed June 19, 2018, http://www.clusterexcellencedenmark.dk/da-DK/Om-Cluster-Excellence-Denmark.aspx.
[108] Uddannelses- og Forskningsministeriet, Styrelsen for Forskning og Innovation, *Klyngestrategi 2.0: Strategi for Danmarks klynge- og netværksindsats 2016–2018*.

investments into firms when private investors were not willing to run the risks involved.[109] The number of robotics firms in which the state has invested shows that the investment into Universal Robots was not an isolated occurrence, but part of a new behavioral pattern in which the Danish state—through various independently acting entities—was willing to act increasingly like a private entrepreneur, as it took the same kind of economic risks as private entrepreneurs, although the goal was not to create profits but to help innovative companies that could become competitive. It was time and time again identified as a foundation for Danish industrial policy that the state, through various initiatives and across policy areas, should make sure that "the broad business conditions for the national business strongholds are at least as good as in the countries of the most important foreign competitors."[110]

The European Level

But what about the level of EU policies? Are there any links between EU policies and the development of the Danish robotics cluster? The answer to this question must be an unequivocal "yes," although EU policies have had a much more indirect effect by setting out frameworks and regulations. The first important development on the European policy level occurred in the beginning of the 1980s, when the European Community began to take a more focused and comprehensive approach to its research and development policy by instituting the first Framework Program for Research and Technological Development (FP1), which ran from 1984 to 1987,[111] and the European Strategic Program on Research in Information Technology (ESPRIT), which ran from 1983 to 1988.[112] The general purpose of the broader FP1 was to coordinate hitherto scattered research and development projects in order to foster a more comprehensive EC policy on research and technology development,[113] while ESPRIT was focused on furthering research in the field of information technology with the aim of strengthening both the cooperation among and the competitiveness of European companies in this sector of industry because they were lagging behind their American and Japanese counterparts.[114] In conjunction with the European Regional Development Fund (ERDF), which had been established in 1975 with the aim of furthering regional development by investing in regional infrastructure and business development,[115] the FP1 and

[109] It has to be mentioned that the Danish government, in an effort to simplify and streamline the Danish innovation system, has decided to phase out its funding of the innovation environments. "Politisk aftale giver et enklere og mere effektivt erhvervsfremmesystem," Erhvervsministeriet, 24.05.2018, accessed June 23, 2019, https://em.dk/nyhedsarkiv/2018/maj/politisk-aftale-giver-et-enklere-og-mere-effektivt-erhvervsfremmesystem/.
[110] Erhvervsministeriet, *Erhvervsredegørelse 1993*, 164.
[111] Guzzetti, *A Brief History of European Union Research Policy*, 83.
[112] Ibid., 78.
[113] Ibid., 83.
[114] Ibid., 76–77.
[115] "The European Regional Development Fund Turns 40," European Commission, accessed September 25, 2020, https://ec.europa.eu/regional_policy/en/newsroom/news/2015/03/european-regional-development-fund-turns-40.

ESPRIT initiatives marked the beginning of a concerted effort on the part of the EU to further research, innovation, and competitiveness within both the private sector as well as the sector of higher education. Although some of the more detailed provisions of the programs and policies have changed over time, the overall aim of these policies has since then intensified and broadened in scope. FP1, for instance, had a budget of 3.8 billion euros, whereas the latest framework program, FP8—known as Horizon 2020—has a budget of 77 billion euros.[116] In this connection it is interesting to note that the shipyard, as early as 1984, participated in an ESPRIT research project that focused on the integration of robotics into production.[117] This preceded the company's cooperation with the university and demonstrates that funding from the EU level has had an impact on robotics research on Funen since the beginning. An attempt was also made to get funding from the EU for the AMROSE project, but it was unsuccessful, and the project was instead financed through funds from the university, the shipyard, and various other sources at the national level.[118]

Furthermore, the creation of the single market and later the European Union increased the need for Danish businesses to specialize and innovate to stay competitive in the face of increased competition from other EU states. This challenge was also echoed in official publications from the Danish Ministry of Industry.[119] This tendency toward accepting the increased European and global competition as a precondition determined a lot of subsequent developments in national industrial policy. An important part of these developments was the reasoning that globalization and Europeanization created larger markets, which in combination with a more rapid pace of innovations in science and information technology put increased pressure on businesses to specialize to stay competitive. As countries and regions typically only developed competitive specialization within a limited number of fields, it was important to identify and nurture specialized clusters to keep them competitive.[120] Thus, much broader policies on the EU level set up a framework, which significantly influenced the course of Danish industrial policy.

Another broad initiative by the EU, which had effects on the development of the robotics industry on Funen, was the ratification of the Lisbon Strategy in 2000, which entailed a plan of turning the EU into "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion."[121] The plan, among other things, entailed provisions for establishing the European Research Area and for improving the conditions for innovative businesses.[122] Therefore, the Lisbon Strategy marked an increased commitment by the EU to further innovation, research, and business development in its member states. This was followed up a few years later with the so-called Barcelona targets, which,

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[116] European Commission, "Research and Innovation Funding: Making a Real Difference."
[117] Christensen, "Skibsbygning og værftsanlæg," 736–737.
[118] Steno, *En klynge, der virker*, 26.
[119] E.g., Ministry of Industry, *Danmark i Det indre marked*, paragraph 5.
[120] Erhvervsfremmestyrelsen, *Kompetenceklynger i dansk erhvervsliv*, 15–38.
[121] European Union Parliament, "Lisbon European Council 23 and 24 March Presidency Conclusion."
[122] Ibid.

among other provisions, set forth a goal "that overall spending on R&D and innovation in the Union should be increased with the aim of approaching 3% of GDP by 2010. Two-thirds of this new investment should come from the private sector."[123] Although no EU funds were tied to this target, it certainly incentivized member states to increase their R&D spending to reach this goal. The Danish Globalization Strategy of 2006 was a national policy that was formulated directly in response to this Barcelona target, as one of its aims was to achieve these benchmarks.[124]

Although it is beyond the scope of this article to provide a comprehensive overview of all the R&D projects conducted with participation from members of the Danish robotics cluster, a few examples will nevertheless be provided in the following section to demonstrate that EU funding has in fact directly contributed to the development of the cluster. Two examples of projects funded by the ERDF are Robots at Play–Joint Creative Growth and AutomationsBoost. The first received DKK 7.268.675 in funding in the period 2008–2010 for a joint project between Robocluster, the university, and the Business College of Southern Denmark with the aim of furthering the development of a robotics festival.[125] The latter received DKK 7.497.574 in the period 2015–2019 for a joint project between Væksthus Syddanmark, the Danish Institute of Technology, Sønderborg Væksthus, the university, and the private company Blue Ocean Robotics, which aimed at creating growth in SMEs in the Region of Southern Denmark by furthering the development of several automation products for subsequent commercialization.[126] Out of fourteen individual product development projects conducted under the AutomationsBoost mantle, ten have been conducted in collaboration with companies that are part of the Danish robotics cluster.[127] These examples demonstrate that companies in the cluster have not only benefited indirectly from the EU broad policies over the past decades, but have also benefited directly from EU policies in the form of funding for R&D projects.

A final example is the EU's policy on business clusters, which was streamlined and intensified in the middle of the 2000s with the establishment for the European Cluster Observatory (ECO) in 2006. The purpose of ECO was to provide "a single access point for statistical information, analysis and mapping of clusters and cluster policy in Europe that is aimed at European, national, regional and local policymakers as well as cluster managers and representatives of SME intermediaries."[128] The aim was to provide better information on European business clusters in order to give member states, regions, and other interested parties the optimal

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[123] European Council, "Presidency Conclusions: Barcelona European Council 15 and 16 March 2002."
[124] Regeringen, "Fremgang, fornyelse og tryghed," 10.
[125] "Robots at Play–Joint Creative Growth," Erhvervsstyrelsen, accessed June 19, 2018, https://regionalt.erhvervsstyrelsen.dk/eu-robots-play-joint-creative-growth.
[126] "AutomationsBoost," Erhvervsstyrelsen, accessed June 19, 2018, https://regionalt.erhvervsstyrelsen.dk/eu-automationsboost.
[127] "Bevilligede projekter i AutomationsBoost," Robocluster, accessed June 19, 2018, https://www.robocluster.dk/projekter/automationsboost/bevilligede-projekter-i-automationsboost.aspx.
[128] "European Cluster Observatory: About," European Commission, accessed June 19, 2018, https://ec.europa.eu/growth/industry/policy/cluster/observatory/about_en.

opportunities for developing strategies to create world-class business clusters.[129] The EU's efforts in this policy area were further increased in 2009 with the launch of the European Cluster Excellence Initiative (ECEI), which set out "to create a benchmarking methodology for cluster organisations to improve their internal management process and the way they offer services.…"[130] The two objectives were handled by the European Secretariat for Cluster Analyses and the European Foundation for Cluster Excellence, respectively.[131] The part of the EU cluster policy that most directly influenced both the robotics cluster on Funen and the national Danish cluster strategy of 2013 was the ECEI's cluster labelling system, which categorized all formal cluster organizations into three categories: bronze, silver, and gold.[132] This labelling system was incorporated into the Danish national cluster strategies, which used it to specify a number of policy goals.[133] On the local policy level, the ECEI's labelling system has had an important influence on the organization and activities of Odense Robotics. According to the business manager of Odense Robotics, the labelling system gave the organization incentives to work toward achieving a gold certification, which significantly strengthened the internal organization of Odense Robotics.[134] Odense Robotics achieved the gold label in May of 2017 by earning ninety-four points out of a possible one hundred points in the ECEI's evaluation process, thereby exceeding the minimal requirement of eighty points by a fair margin. That Odense Robotics managed to do this just two years after its creation is a rare achievement according to a statement made by the director of Cluster Excellence Denmark.[135] The framing influence of the ECEI's labelling system on the development of the formal cluster organization of the robotics industry on Funen is therefore a very tangible one. The EU's policies on business clusters are therefore particularly well suited for demonstrating the interconnectedness between the three levels of public policy making in contemporary European capitalism and the importance of public actors and even public direct investment.

It is, however, difficult to assess the exact level of public investment vis-à-vis private investments in the cluster. According to s *Insight Report 2019*, the total investments in the Danish robotics cluster's companies reached EUR 750 million in the period 2015–2018,[136] out of which public funding or soft money made up somewhere between 2 percent[137] and 28 percent, depending

[129] Ibid.
[130] "European Clusters Excellence," European Commission, accessed June 19, 2018, https://ec.europa.eu/growth/industry/policy/cluster/excellence_en
[131] Ibid.
[132] For detailed information on the benchmarking and labelling process of the ECEI, go to the ESCA web page, https://www.cluster-analysis.org/.
[133] Ministeriet for Forskning, Innovation og Videregående Uddannelser, *Strategi for samarbejde om Danmarks klynge- og Netværksindsats*; Uddannelses- og Forskningsministeriet, Styrelsen for Forskning og Innovation, *Klyngestrategi 2.0: Strategi for Danmarks klynge- og netværksindsats 2016–2018*.
[134] Mikkel Christoffersen (Cluster Director of Odense Robotics), interview by Julian Lamberty, October 23, 2017, Odense.
[135] "Gold for Danish Cluster, Odense Robotics," Odense Robotics, accessed June 19, 2018, https://www.odenserobotics.dk/gold-for-danish-cluster-odense-robotics/.
[136] Odense Robotics, *Insight Report 2019*, 23.
[137] The number of 2 percent public funding/soft money is claimed by Odense Seed and Venture, "Bridging the Gap

on what kind of measure is used.[138] It is difficult to reach an exact amount for the public funding being invested into the Danish robotics cluster. However, when the above estimates are held up against the annual turnover of the companies in the Danish robotics cluster of EUR 763 million for 2017 alone,[139] this serves to illustrate that the success of the Danish robotics cluster is not the result of public investments artificially propping up a business cluster, as public money does at best account for a fraction of the cluster's turnover.

Conclusions

All in all, it seems fair to conclude that public agents and institutions have played a very important role in the development of the Danish robotics cluster, and that an entrepreneurial success story such as Universal Robots would not have been possible without these public initiatives—just as it would certainly not have been possible without the entrepreneurs or the capitalists, most importantly the Maersk Group and its shipyard. It also stands out as a conclusion that public institutions have not only functioned as facilitators of innovation but also as agents of risk, although the first role certainly stands out as the dominant trend. There are moments in the story of this cluster that confirm Mazzucato's statement about the state being willing to take risks that private investors are not willing to take, but they are few, and even in the years when the entrepreneurial spirit in the public sector was at its highest, it was a crucial part of the thinking behind such instances that the state should only "fill the gaps" between private investors.

It also emerges as a conclusion that public sector agents functioned in different ways at the different levels, from the local through the national to the European level. As shown in the section on the EU, institutions at this level mostly acted as framing and facilitating agents, often setting the stage for national and local discourses and initiatives, while the national policy makers functioned as intermediaries—though they also retained the freedom to initiate their own agendas—and public actors on the local level of policy making have had the most direct engagement. Although this is, perhaps, not so surprising, it could be emphasized as an important finding that there are surprisingly many connections in between the layers, and that the different activities connecting these layers were connected by a certain *zeitgeist*—the idea of public institutions taking responsibility for the competitiveness of private companies, an idea that seems to have blossomed especially from the 1990s to the early 2000s. This period saw the emergence of an almost entrepreneurial spirit in the public sector in which actors on both the national and local levels showed an increased willingness to support developing entrepreneurs, not least by investing public money either directly into

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between Startups and Investors," web. 04.06.2019, https://www.odenseseedandventure.dk/.

[138] The number of 2 percent public funding/soft money is claimed by Odense Seed and Venture, "Bridging the Gap between Startups and Investors," web. 04.06.2019, https://www.odenseseedandventure.dk/.

[139] Although this data is also provided by Odense Robotics, *Insight Report 2019*, the calculations for the total turnover of 2017 is based on data from Statistics Denmark (the central authority on statistics in Denmark), which is deemed a reliable source of data. Odense Robotics, *Insight Report 2019*, 18

innovative startup companies or into supporting initiatives like the StartUp Hub. Thus, this study shows how politics, culture, and business are intertwined and that the development of capitalist systems and of companies and their interactions with public institutions is very much influenced by the spirit of a certain period. In other words, what really unites these efforts of the entrepreneurial state is closer to an underlying thought collective than an actual plan, an underlying structure that made the workings of the entrepreneurial state very flexible and fit for the uncertain and highly unpredictable nature of business innovation.

Most generally, this study shows that there was no withering away of industrial policy and the role of the state in the age of neoliberalism and high globalization. This story does not support the commonly held view that as countries develop and globalize, the states become less active and industrial policy disappears. Rather, this is a story of industrial policy changing its aim and form, with the support of developing industrial clusters as a particularly illustrative example. Thus, instead of a shift from "state" to "market" in the era of neoliberalism, this article points toward rising complexity in state-market relations as a more fitting description of the main trend. Whereas traditional support of national champions and direct subsidization certainly faded in this period, new types of direct support of startups and venture-like investments indicate a new paradigm of industrial policy. The term *entrepreneurial state* certainly fits many of these developments, although the state orientation embedded in this term should not overshadow the continued importance of the private initiatives in the actual development of the cluster, or of the public actors' strong focus on keeping the private entrepreneurs and the private investors center stage.

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