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Destruction and Reallocation of Skills Following Large Company Exit

Jacob Rubæk Holm
Aalborg University
Department of Business and Management
jrh@business.aau.dk

Christian Richter Østergaard
Aalborg University
Department of Business and Management
cro@business.aau.dk

Thomas Roslyng Olesen
Copenhagen Business School
Department of Innovation and Organizational Economics
tro.ino@cbs.dk

Abstract

What happens to redundant skills and workers when a large company closes down in a region? The knowledge embodied in firms is lost when firms exit. However, the skills, competences and knowledge embodied in the displaced employees are suddenly released and can become channels of knowledge transfer for other firms that hire them. This process can be very disruptive. For instance, when a large, old and well-renowned company closes down displacing thousands of workers over a short period of time, then it may be a shock to the regional economy and lead to unemployment and skill destruction. The question then becomes: under which conditions are the redundant workers and their skills reallocated to productive use elsewhere in the regional economy and when do the workers find a job where their specific skills are less valuable to the new employer and the worker must start over acquiring new skills, that is, skill destruction. This study is based on the closure of four shipyards in Denmark from 1987-2000. The analysis is based on detailed longitudinal micro data from a matched employer-employee dataset that allow us to follow the mobility of the laid-off employees in great detail.

The analysis shows that mobility of workers to related industries leads to less skill destruction. The presence of related industries in the region matters for the extent of skill reallocation and skill destruction. The voluntarily mobile displaced workers also experience less skill destruction, because they find a job that matches their current skills.

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1 Introduction

What happens to redundant skills and workers when a large company closes down in a region? The knowledge embodied in firms is lost when firms exit. However, the skills, competences and knowledge embodied in the displaced employees are suddenly released and can become channels of knowledge transfer and productivity growth for other firms that hire them (Almeida and Kogut, 1999; Song et al., 2003; Boschma et al., 2009; Hoetker and Agarwal, 2009; Boschma and Frenken, 2011; Timmermans and Boschma, 2014) and in spin-off firms (Buenstorf and Fornahl, 2009) Thus, firm closure might lead to reallocation of skills, destruction of skills or both. Creative destruction of firms, jobs, routines and skills is a necessary element in economic evolution (Schumpeter, 1950). Similarly, the churn of companies is a common process in regional development and change (Neffke et al., 2011). This process can be very disruptive. For instance, when a large, old and well-renowned company closes down displacing thousands of workers over a short period of time, then it may be a shock to the regional economy and lead to unemployment and skill destruction. The question then becomes: under which conditions are the redundant workers and their skills reallocated to productive use elsewhere in the regional economy and when do the workers find a job where their specific skills are less valuable to the new employer and the worker must start over acquiring new skills, that is, skill destruction.

Many studies of regional industrial transformation show that new industries replace the old industries and often end up having a higher employment. For example Buenstorf and Fornahl (2009) finds that the sudden decline of the large IT firm Intershop in Jena, Germany, created several spinoffs that eight years later had more employees combined than the mother company had when it closed down. But this does not tell the full story of the displaced employees and the reallocation of skills. It is not apparent from the success in Jena that the displaced Intershop employees found new employment. Moreover we do not know if their specific skills were applied in their new firm or if it was just more general skills that were being used. That is, if the forced labour mobility led to skill reallocation or to the destruction of firm specific and industry specific skills. Company closure is an important process in regional development, but studies focusing on the how the displaced workers' skills are being reallocated or destroyed are scarce (Neal, 1995; Parent, 2000; de Faria et al. 2013). Furthermore, as far as we are aware, the study presented in the current paper is the first investigation of how regional conditions affect what happens to the employees from closure of large companies and how their skills are being reallocated. We argue that skill reallocation and destruction depend on the presence of skill related industries in the region, since geographical job mobility is limited (Dahl and Sorenson, 2010) and that employees are more likely to have their skills reemployed when they find a new job in an industry with high skill-relatedness than when they move to an unrelated industry (Neffke et al. 2011; Neffke and Henning, 2013). Furthermore,

the result also depends on how the company closes down and if the job mobility is voluntary or involuntary.

This study is based on the closure of four shipyards in Denmark from 1987-2000. The analysis is based on detailed longitudinal micro data from a matched employer-employee dataset that allow us to follow the mobility of the laid-off employees in great detail. Furthermore, we also use qualitative data on the closure processes to aid in interpreting regression results.

For each shipyard we identify the people that lost their job when it closed down (ranging from 1,376 to 4,599 per shipyard). The shares of displaced employees that get a new job range from 82% to 91%. We approximate the reuse of skills in the new job by the wage in the new job. That is, how the new employer values the employee's skills (Neal, 1995; Parent, 2000; de Faria et al., 2013). The average worker who finds a new job gets roughly the same wage in the new job as at the shipyard. This indicates that the regional economy managed to reallocate the skills of the workers. But underlying this mean behaviour is much heterogeneity. Some workers' skills are reemployed in firms where they are more valuable. This can be explained by the skill-relatedness of industries (Neffke and Henning, 2013). There are, however, also a large number of worker that receive a much lower wage in the new job indicating that their skills were not valuable elsewhere in the regional economic system. They experienced skill destruction because they were not able to find jobs in skill-related industries.

There is also large discrepancy in skill destruction and reallocation between voluntary and involuntary job-to-job mobility, where the voluntary mobile workers experience less skill destruction. A potential problem is that workers with skills that can easily be reallocated choose to change job immediately, while the others stay until the company closes. However, there is no pattern in the timing of workers leaving the shipyard to support this problem. In addition, prior research has found no indication of such behaviour (Schwerdt, 2011).The characteristics of the regional industry also have an effect on the region's ability to reallocate redundant skills when a large firm closes down. If there is strong skill-relatedness between the closed down firm and the regional industry then employees' skills seem more likely to be reallocated rather than destroyed. The intervention of local policy makers, organisations, private individuals, and not least the owner of the firm may significantly mediate the effect. Regions with large and diverse labour markets see much destruction of skills if the company is left to crash and burn, while the creation of spinoff companies and workplaces gives the displaced workers opportunity to reallocate their skills. Location in a peripheral region where the shipyard accounts for a large share of the employment increases the extent of skill destruction.

The paper is structured as follows: theories on relatedness, regional economic evolution and the destruction and reallocation of skills following large company closure is presented in the following section. Section 3 describes the decline of the Danish shipbuilding industry and the processes of closing down four ship yards. Section 4 presents the data and methodology and in Section 5 the extent of skill destruction and reallocation is analysed empirically. Section 6 concludes and discusses the importance of the availability of regional related industries and how companies close down.

2 Large company closure, labour mobility and re-use of skills

How regions' industry structure diversifies over time is a key issue in economic geography. Economic evolution of regions is affected by entrepreneurship and job creation, but also by the creative destruction of industries, firms and skills (Schumpeter, 1950; Storper and Walker, 1989). As a result, even stable regional economies are facing a continuous churn of firms and jobs that change the use of skills (Rigby and Essletzbichler, 2000; Essletzbichler, 2004; Brown et al., 2013). Recently, attention has focused on regional branching where regional industries and firms tend to diversify into technology–related or skill-related areas (Boschma and Frenken, 2011; Neffke et al., 2011; Boschma et al., 2013; Neffke and Henning, 2013; Essletzbichler, 2013). The main arguments are that regional knowledge spillovers are more likely to occur between related industries (Boschma and Frenken, 2011); firms diversify into skill-related industries in order to leverage their employees' human capital (Neffke and Henning, 2013); firms that hire employees from related industries rather than similar industries perform better (Boschma et al., 2009; Timmermans and Boschma, 2014) and new successful firms in a region are likely to be related to the existing industry structure, while firms that are unrelated to the regional industry structure are more likely to exit (Neffke et al., 2011; Boschma et al., 2013; Essletzbichler, 2013). The industry relatedness is a measure of how similar two industries are in terms of their knowledge base, human capital and skills defined by the extent of inter-industry labour flows (Neffke and Henning, 2013).

A key factor in these processes is the flow of knowledge and skills embodied in the firms' employees through spinoffs or labour mobility (Boschma and Frenken, 2011). Labour mobility is often considered as an important interfirm knowledge transfer mechanism that also allows the transfer of tacit knowledge such as skills (Almeida and Kogut, 1999; Song et al., 2003; Boschma et al., 2009; Malecki, 2010; Boschma and Frenken, 2011). Furthermore, labour mobility mainly takes place within the same region, since employees tend to value social factors, such as closeness to current hometown, parents, classmates, and siblings higher than economic factors (Dahl and Sorenson, 2010). Thus, knowledge flows through labour mobility is a highly localized process that together with the routine replication that takes place through spinoff activities tend to favour the evolution of the regional industries into related technological areas (Boschma and Frenken, 2011; Boschma et al., 2013). In addition, knowledge transfer and learning is more likely to take place between cognitively close organizations (Nooteboom, 2000; Song et al., 2003). Therefore, labour mobility between related industries is more likely to lead to knowledge transfer, while mobility between unrelated industries also leads to 'new knowledge' in the receiving firm, but also to increased costs of communication and interaction between the two different knowledge bases. As a result, mobility between unrelated industries renders a part of the new employee's knowledge and skills obsolete, because it is too distant from the knowledge and skills required in the new job.

However, labour mobility and diversification of the regional industry is not always voluntary. The continuous churn of companies and jobs cause a change in the use of knowledge and skills present in a region. When a large company closes down in a region a large number of workers and their skills are suddenly becoming redundant. A part of the knowledge embodied in firms is lost when firms close down, since the knowledge of the firm is more than the sum of the knowledge of the employees. But

the skills, competences and knowledge embodied in the displaced employees are suddenly free and it can lead to knowledge transfer through mobility for other firms (Hoetker and Agarwal, 2009). However, as argued above, the extent of knowledge transfer or skill-reallocation is likely to depend on the relatedness of the knowledge base between the freed up workers and the hiring firms. Similarly, Palomeras and Melero (2010) argues that mobility allows for the transfer of knowledge if the distance is not too far to create complementarities, but it also leads to destruction of the knowledge that is specific to the old firm.

Nelson and Winter (1982) defines a skill as "… a capability for a smooth sequence of coordinated behaviour that is ordinarily effective relative to its objectives, given the context in which it normally occurs" (p. 73). A dominating element in "the context" is the organisation in which the worker is employed and when this is changed there is no guarantee that the skill is still "effective". Skills are tacit knowledge which cannot be transferred between firms easily and which can only be created through trial-and-error learning (Lundvall, 2004; Malecki, 2010). The skills of a given worker are superfluous for some of the firm's routines, substitutable for other routines and indispensable for others. Skills evolve over time as those that are used are refined, while skills that are not used wither (Lundvall, 2004). Firms have routines for determining the wages of workers and the resulting wage structure depends on considerations of the scarcity of the worker's skills, the responsibility he bears, his overall contribution to the organisation and a consideration of fairness versus incentives (Beaumont and Harris, 2003).

Skills are continuously moulded to fit into context (Nelson and Winter, 1982) and the skills of a worker are thus moulded to fit the routines of the firm. Thus when an employee is forced to find a new job, he is better suited for jobs where he can be part of routines, which rely on similar skills as the routines of his former job. A part of his skills will be specific to the old firm or its industry while some will also be useful for firms in skill-related industries. Therefore, the fit between the worker's skills and the skills required in the new job are reflected in the wage in the new job. Wage will not only reflect the current skills of the worker but also the potential for acquiring new skills. Workers have higher order skills for acquiring new skills (Nelson and Winter, 1982) and formal education can be seen as a signal of such higher order skills. Thus workers with more formal education can be expected to receive a higher wage than other workers in the new job.

In labour economics, skills are often divided into general skills and specific skills where the later relate to a specific firm, industry or task (Neal, 1995; Parent, 2000; Gathmann and Schönberg, 2010). When it comes to job mobility, the general skills are easily transferable, while the specific skills are only partly transferable to the new job depending on the similarity between the two jobs (Gathmann and Schönberg, 2010). In addition, industry-specific skills matter more than firm-specific skills for the wage profile of workers (Parent, 2000). Furthermore, studies of displaced workers find that replacement costs in terms of lower wages are less for workers staying in the industry or moving to related industries performing similar types of routines (Neal, 1995; Gathmann and Schönberg, 2010; Schwerdt, 2010). This indicates that the level of skill-destruction is less for workers that are able to find a job in a skill-related industry, while workers that switch to an unrelated industry suffer from a greater skill-destruction since their new employer assigns little value to their specific skills.

Hypothesis 1: The extent of skill destruction is less for displaced workers who find a job in a skill related industry compared to workers who find a job in an unrelated industry.

The geographical mobility of workers from a workplace that closed down is limited and quite similar to other types of mobility (Dahl and Sorenson, 2010). Dahl and Sorenson (2010) finds that proximity to current home is the most important factor for job mobility for workers from a closing workplace followed by distance to parents. Since the extent of skill reallocation and destruction depends on the movement to a related industry then the availability of related industries in the region is likely to limit the overall extent of skill destruction. Furthermore, the exit of an industry in a region can trigger the exit of a set of related industries if these become unrelated to the regional industrial portfolio (Neffke et al., 2011).

Hypothesis 2: The extent of skill reallocation or destruction of displaced employees depends on the presence of skill related industries in the region.

The existing literature on the industry relatedness measured by interindustry labour flows does not distinguish between voluntary and involuntary labour flows (Neffke and Henning, 2013). However, voluntary mobility is more likely to be skill reallocation than skill destruction. That is, the workers would prefer to move to a skill related industry where their skills are being valued the highest and where current skills are being reapplied. In addition, Gathmann and Schönberg (2010) finds that wage losses are lower for displaced workers in skill related occupations.

Hypothesis 3: Voluntary mobility leads to less skill destruction compared to involuntary mobility.

The process of closing a plant can differ from an orderly closing down process where the firm tries to sell off activities and support the establishment of spinoffs to a chaotic closing down where there is no attempt to continue profitable parts of the company and it is simply left to crash and burn. Spinoffs are a way to replicate the routines of the existing company (Boschma and Frenken, 2011). In addition, sometimes the mass layoffs set a spinoff process in motion that lead to the formation of many new companies (Buenstorf and Fornahl, 2009). Thus, the displaced workers who get a job at either parent spinoffs or entrepreneurial spinoffs from the exiting company are likely to enter a job where they can reuse their skills and competences.

Hypothesis 4: Finding employment at a spinoff company leads to less skill destruction.

When a large company closes down it lays off many workers that subsequently can be a source of knowledge flows to other firms in the region depending on the skill relatedness between these. However, not all displaced workers find a new job, but end up being unemployed for a long period or are to some extent forced into retirement. Other workers re-enter the educational system for a period and upgrade their formal education. Both processes lead to a skill destruction of skills related to the closed firm. However, by getting a new education the worker becomes able to achieve new skills that are likely to have a positive effect on the wage.

3 Decline of the Danish Shipyard industry

The Danish Shipyard industry used to be a strong industry closely connected to the large Danish commercial fleet. During the 1970s and 1980s it faced increased competition from in particular Korean and Japanese shipyards like the rest of the European shipyard industry. In addition, the world-wide shipping industry and the shipbuilding industry were characterized by overcapacity, fierce competition and various forms of governmental support programs, and they were afflicted heavily by the two oil crises in the 1970s. Subsequently the shipbuilding industry declined in most European countries. The Danish shipbuilding industry was favoured by a governmental subsidy program in the form of tax reductions for financing the building of ships during the early 1980s until 1986, when the government removed these as a part of a larger fiscal policy contraction. In 1990 the export share of the Danish shipbuilding industry was three times higher than the average of OECD export shares. In 2003 it was lower than the OECD average. The closure of shipyards across Denmark was thus not so much economic selection on particular companies but rather steps in a process of economic selection among industries, where the production of ships in the Danish economy grew even as it declined across Europe in the 1960s and 1970, but eventually declined in the 1980s and 1990s where the industry expanded in Asia (Poulsen and Sornn-Friese, 2011).

Shipbuilding was considered to be a medium technically advanced industry that employed many skilled workers and the Danish shipbuilding industry was characterized by technological development, innovations and niche production (Poulsen and Sornn-Friese, 2011). The shipbuilding industry was traditionally a cyclical industry that was sensitive to changes in the business cycle. As a result most shipyards also did repair work and had a somewhat diversified production in order to retain the workforce during recessions. Furthermore, shipbuilding is a labour intensive industry that draws on many types of skills, such as metal works, wood works, electrical works, joinery etc. Even during recessions the shipyards needed to keep a fairly large workforce and a broad set of skills in order to be able to build a ship.

The four Danish shipyard closures that we follow are: Nakskov Skibsværft which closed down in December 1986; Aalborg Værft which was merged with Danyard Frederikshavn in January 1987 and finally shut down in March 1988; Burmeister & Wain Shipyard (B&W), which closed down in April 1996 and Danyard Frederikshavn which closed down in December 1999. These closures are quite evident from the evolution of full time equivalent employment in the shipbuilding industry as presented in Figure 1. But the full impact is likely to be understated, as subcontractors are not taken into account.

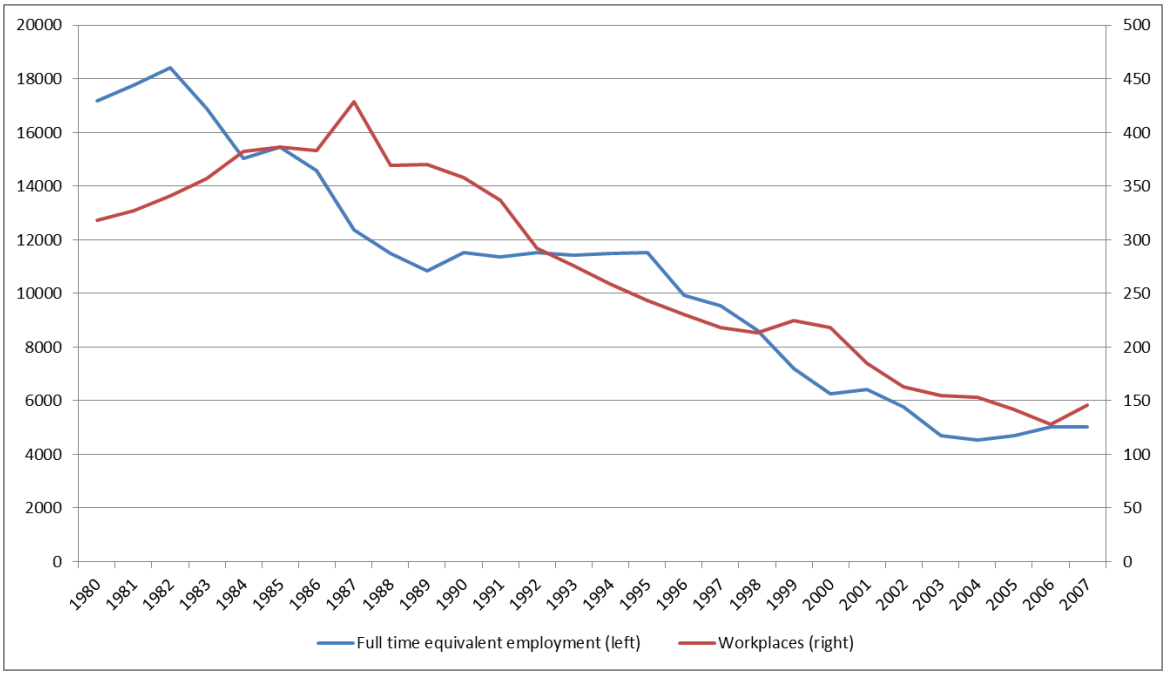

Figure 1: The Danish shipyard industry (NACE rev. 1 industry 351: "Manufacturing and maintenance of ships and boats")

The shipyards represent quite diverse narratives. Nakskov Skibsværft was located in a peripheral region on an island in the south of Denmark. Aalborg Værft was located in Aalborg, the fourth largest city of Denmark with a diverse set of alternative employers including smaller shipyards. B&W was located in central Copenhagen potentially offering a plethora of opportunities for the redundant workers to find use of their skills. The last shipyard was Danyard Frederikshavn, which was located in a peripheral region north of Aalborg. When it closed down, the industry was still relatively large in the region.

The following sections describe the processes of closing down the four shipyards. The intention is to highlight the differences between the four regions, closure processes, ownership structures, product portfolios and organisations as these are expected to contribute in explaining the differences in the results of the econometric analyses of Section 5.

3.1 Aalborg Værft

Aalborg Værft was established in 1912 and since 1937 it had been controlled by the Danish shipping conglomerate J. Lauritzen. At the time when Aalborg Værft closed down J. Lauritzen also owned Danyard Frederikshavn and a shipyard in Elsinore as well as several other firms. Aalborg Værft generally built specialized ships, such as reefers and cruise ships, rather than series of standardised ships and had diversified into production of marine- and industrial boilers already in 1919. It diversified further into the offshore sector in the 1970s and when Aalborg Værft closed down it had three separate divisions: offshore, boilers and shipbuilding. Over its lifetime, however, it had at various times diversified much wider and produced, among other things, residential housing, steel bridges and refrigerators (Nielsen, 2012).

The closure of Aalborg Værft took place in two phases – both with a very short notice. After a number of years with continuously impressive financial performance in the mid-1980s, a lack of new orders combined with serious problems in the offshore division resulted in a very large deficit for 1986. In January 1987 Aalborg Værft was merged with J. Lauritzen's shipyards in Elsinore and Frederikshavn in order to achieve economies of scale. The merger, however, didn't solve the problems, and in March 1988 it was decided to shut down all steel shipbuilding activities in Aalborg (Olesen, 2012).

The 1987-closure saw several layoffs, but the management made several attempts to maintain a skill base of around 700 employees waiting for the market to turn for as long as possible. This was mainly done by transferring employees from shipbuilding to the boiler and offshore divisions. At the subsequent merger the management made an effort to identify and continue the profitable activities leading to the establishment of several spin-off companies. This was done partly because some activities showed great potential, but also as an act of corporate social responsibility on the part of J. Lauritzen, who emphasized the importance of creating new jobs to the former shipyard employees. The boiler division spun-off into two new firms and Aalborg Værft was transformed into a real-estate company under J. Lauritzen, which also acted as the mother firm of the two new boiler firms. In collaboration with the local municipality and with Aalborg University, Aalborg Værft set up a business park on the former shipyard site and was somewhat successful in attracting new firms. By 1989 approximately 2,000 jobs were created in the business park. In the short run, it would seem that many of the activities undertaken by Aalborg Værft carried on in new ownership constellations but this did not entail that the workers and skills made redundant at the closure of the shipyard were able to be reemployed (Nielsen, 2012).

The final closure in March 1988 saw no attempts to maintain the employees, as the decision was taken on a very short notice, and the remaining ship could be finished in Frederikshavn. The 1988-closure, however, also saw a few spin-offs. Fibreglass ship construction and production of steel elements were spun off into separate firms. In addition to these companies several smaller spin-offs, many of them quite successful in terms of job creation, were created by former employees.

3.2 Danyard Frederikshavn

Danyard Frederikshavn was also owned by the shipping conglomerate J. Lauritzen since 1964, though the shipyard's history goes back to 1870. Since the late 1970s Danyard Frederikshavn had specialized in a variety of niche productions ranging from ferries and naval ships to reefers and highly specialized chemical tankers. Danyard Frederikshavn had no important related activities besides shipbuilding, but the chemical tankers were so specialised that the Danyard Frederikshavn production site effectively included a pipeline factory (Olesen, 2012).

Danyard Frederikshavn exhibited poor financial performance in a number of years in the mid-1990s and in October 1998 it was decided to close down the company when the remaining orders had been completed. In an attempt to finish the remaining orders on time the management decided not to announce the decision to close the shipyard to the employees. In order to keep down costs, however, the management was forced to begin laying off workers and by January 1999 it was obvious that the shipyard would close. By application of financial incentive schemes in the workforce, however, Danyard Frederikshavn managed to finish the last ship on time in December 1999 (Christensen, 2010).

Through 1999 the management worked to identify the healthy parts of the company. The plan included the establishment of a repair shipyard and a business park in an attempt to secure new jobs for the former shipyard employees. The business park – Frederikshavn Maritime Erhvervspark – was eventually established in the summer of 1999 as a daughter company of J. Lauritzen. The continuation of a repair yard was, however, given up when another shipyard in Frederikshavn decided to rent and later buy a considerable part of the Danyard Frederikshavn site. The business park was relatively successful in attracting firms and some of the activities from Danyard Frederikshavn were also successfully spun out by management into new firms including pipeline production (Olesen, 2012).

3.3 Nakskov Skibsværft

Nakskov Skibsværft was established in 1916 in the town of Nakskov on the island of Lolland. Since 1939 the shipyard was 100% owned by East Asiatic Company (EAC). It was an important workplace in the peripheral region. In 1980 approximately 50% of all industrial workers on Lolland were working on the shipyard. The company performed badly in the early 1980s and only direct intervention by the Danish government, which decided to order two new ferries for the state railway company, kept the shipyard from closing down (Olesen, 2012).

Nakskov Skibsværft was located at the bottom of a narrow fjord and was thus forced to specialize in small complicated ship types like ferries and product carriers. Apart from shipbuilding the shipyard had a production of steel bridge sections and it attempted to diversify into the offshore sector. However, in July 1986 management announced that the shipyard would close after the completion of the remaining orders and in December all activities were shut down. Already a few years before the shipyard closed down the local municipality had initiated an active policy for attracting firms from the rest of Denmark. Publicly funded vocational training was used to improve the workers' skills, and two organisations were founded with the explicit aim of aiding in the transfer of technological knowledge to local companies (Olesen, 2012).

As with J. Lauritzen in the cases of Aalborg Værft and Danyard Frederikshavn, EAC made an effort to support the local community when closing the shipyard. EAC, in collaboration with a number of financial companies and other organisations, established a foundation to finance business development on western Lolland. The foundation, Lalandia Invest, acted as an important investor in new businesses in the region and in attracting other companies to the region. The shipyard became a real-estate company, but not with the explicit aim of creating a business park, as was seen in the cases of Aalborg Værft and Danyard Frederikshavn. Local businessmen with finance from Lalandia Invest initiated new activities, among other things, a repair-yard at the old docks and a metal work subcontractor for the B&W shipyard in Copenhagen (Olesen, 2012).

3.4 Burmeister & Wain

Burmeister & Wain Shipyard (B&W) in Copenhagen was established in July 1980 based on the remnants of the defunct B&W Group. B&W was located in the centre of Copenhagen. In contrast to most Danish shipyards B&W continued to build non-specialised ships in series, such as bulk carriers and product carriers and thus competed directly with the low cost Asian shipyards. It also differed from most other Danish shipyards by having no other activities than ship building. Thus, there were no specialised

elements that could readily be continued in new firms or by other firms. Since 1989 B&W was owned by B&W Holding which also owned the shipping company B&W Shipholding. Unlike EAC and J. Lauritzen, however, B&W Holding was practically a shipyard with its own shipping company rather than a conglomerate of shipping companies, shipyards and other companies (Olesen, 2012).

B&W was forced into receivership in June 1995 after just one year of bad financial performance, where a number of events imposed extremely large losses on the company. Several attempts were made to reconstruct the shipyard, but infighting among managers, share owners, workers and creditors meant that the plans were never implemented. During the receivership the shipbuilding activities were allowed to be continued in order to finish the remaining orders. This process lasted until March 1996. The following month the shipyard was finally declared bankrupt. No activities were continued after the closure but a few employees did manage to start up spin-offs. A real-estate company was set up to let the land and buildings, but no business park was created and no new companies established on the former site (Olesen, 2012).

4 Methods and data

The regression analyses are based on longitudinal registry data from the integrated database for labour market research supplied by Statistics Denmark (DST) and should be interpreted in conjunction with the above descriptions of the four shipyards. The database contains detailed information on each employed person in Denmark from 1980 onwards, including detailed information on their workplace.[1] In the descriptions of the shipyards it was stated that Nakskov Skibsværft closed down in December 1987, Aalborg in March 1988, B&W in April 1996 and Danyard in December 1999. However, the data pertain to November and most of the shipyards continued to exist as companies after the closure. So the year of closure is defined as the first year in which the company had so low employment that is seems unlikely that it was still producing ships. This means that Nakskov and Aalborg closed down in 1987, B&W in 1996 and Danyard in 2000. Throughout the analyses the year of closure will be referred to as year zero for any given shipyard and other years will be referred to with reference to this. Employment in year zero +/- two years can be seen in Table 1.

Table 1: Employment at the shipyards around year zero

	Y_{0-2}	Y_{0-1}	Y_0	Y_{0+1}	Y_{0+2}
Nakskov Skibsværft	984	554	26	9	8
Aalborg Værft	3965	2651	0	19	16
B&W	1773	1067	128	0	0
Danyard Frederikshavn	897	373	36	18	0

[1] Based on the descriptions of the shipyards it is relatively straightforward to identify the relevant firms and workplaces in the database even though the identification numbers are encrypted. It is not generally permitted to identify individual firms, workplaces or persons in the database but permission has been given to identify these four shipyards and their workplaces for this research. Individual persons are not identified.

As described above the closure of a shipyard was often an abrupt process, but in some cases workers started leaving the shipyards in the years prior to closure and it is necessary to include workers that left the shipyard more than just the year prior to closure.[2] This means that the set of workers analysed for any given shipyard contains anyone who had the shipyard as their primary workplace in the three years prior to closure. The data used for each worker pertains to the last year at which he was employed at the shipyard. For each worker the database is then scanned for the years 0-2 to 0+7 to find out when he re-entered employment. This data collection process is illustrated in Figure 2.

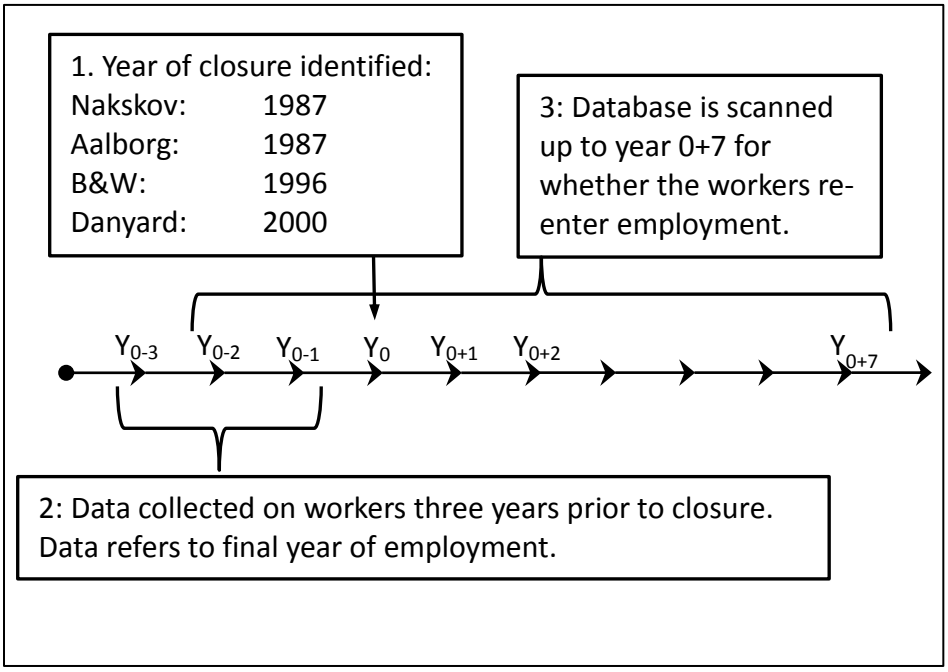

Figure 2: Data collection process

The choice of years to include in data collection is partially based on practical concerns. The last year with comparable data is 2007 so year 0+7 is the maximum allowed for in the analysis of Danyard.

Table 2: Number of workers and percentage of gross population

	Nakskov		Aalborg		B&W		Danyard	
Gross population	1382	100%	4599	100%	2043	100%	1377	100%
Does not return to work	255	18%	431	9%	368	18%	160	12%
Net population	1086	79%	3526	77%	1644	80%	1183	86%
In regressions	898	65%	3249	71%	1541	75%	1092	79%

[2] In labor market economics, closure is often treated as an exogenous event and studies have shown that workers that leave until six months before the closure should be included in group that stays until the closure (Schwerdt, 2011).

Table 2 shows the number of workers identified by the algorithm illustrated in Figure 2. The number of workers identified as having worked at a shipyard in any of the three years prior to year zero is referred to as the gross population. As is seen, Aalborg was by a wide margin the largest shipyard by this measure. In the second step 9 to 18 per cent of workers do not reappear in the database again within seven years of the shipyards' closure with a valid estimate for hourly wage (see below). The number of workers that ever find employment again is referred to as the net population. In addition to those that do not return to work we must also exclude workers for which we do not have a valid estimate of their hourly wage at the shipyard from the net population. Wage is measured by the hourly wage estimate supplied in IDA by DST.[3] There are a number of observations with missing data for the analyses' independent variables and as a result 65 to79 per cent of the gross populations is available for regression analysis.

4.1 Relatedness

Hypothesis 1 argues that workers' skills are more likely to be reallocated and less likely to be destroyed when their new job is in a skill related industry. In order to measure the skill relatedness of industries we use the approach of Neffke et al. (2013). The workers enter jobs over a period of 23 years (year 0-2 for Aalborg, 1985 to year 0+7 for Danyard, 2007) and in order to have an industry classification that covers the entire period it is necessary to use DST's "111 grouping for publication purposes". The approach consists of measuring the skill relatedness of two industries by the labour flows between them. The index is constructed as follows. F_{ij} is the flow of workers from industry i to industry j. This means that F_{ij} is the number of workers working in industry j in November in the current year, but who were working in industry i in November last year. $F_{i.} = \sum_{j \neq i} F_{ij}$ is the total flow out of industry i and $F_{.j} = \sum_{i \neq j} F_{ij}$ is the total flow into j and $F_{..} = \sum_i \sum_{j \neq i} F_{ij}$ is total flows in the economy.

The ratio of observed flows to expected flows can then be computed as R_{ij}:

$$R_{ij} = \frac{F_{ij} F_{..}}{F_{i.} F_{.j}}$$

If observed flows from i to j are greater than expected flows then i is related to j and R_{ij} will take on a value greater than one. By normalizing the index it becomes more convenient to interpret:

$$\bar{R}_{ij} = \frac{R_{ij} - 1}{R_{ij} + 1}$$

[3] DST computes this estimate by dividing total wages, as reported to the Danish tax authorities by the employer, with the number of hours performed by the worker. A worker's hours at a given employer are approximated by his compulsory pension payments. For a worker with full time employment this approximation is accurate but it is relatively uncertain if the worker has had part time employment over the year. DST provides an index of the quality of the estimated hourly wage based on the share of part time employment over the year. DST argues that this estimate should be treated with caution if this fraction is greater than 0.5. Therefore these workers are excluded. A worker is considered to have returned to work the first year that the hourly wage estimate is valid. DST reports that comparing the estimate to hourly wage computed from hours and wages as specified in employment contracts shows that the estimate is very precise and even superior to the latter for blue collar workers, as these tend to have much overtime work (Statistics Denmark, 1991).

$\bar{R}_{ij}$ takes on values from -1 ($R_{ij} = 0$, completely unrelated) and approaches +1 as R_{ij} approaches infinity (completely related). If observed flows equal expected flows; that is, if the industries are neither related nor unrelated, then $R_{ij} = 1$ and $\bar{R}_{ij} = 0$.

Skill relatedness evolves over time as organisational practices and technology in a broad sense changes (Neffke and Henning, 2013) so it is necessary to compute relatedness indices separately for each shipyard. The indices are computed by pooling inter industry job-to-job mobility for the three years prior to year zero at the national level. The relatedness of the shipbuilding industry to itself is defined to be $\bar{R}_{ij} = 1$.

The top 10 industries in terms of re-employing redundant shipyard workers are shown for the time of closure for each shipyard in Tables 7 to 10 in the appendix. The tables also shows the size of these industries as shares of full time equivalent (FTE) employment in the functional urban region (FUR) and skill relatedness to ship building. Many of these industries are closely related to shipbuilding, but there are a number of noticeable exceptions, such as “General public service activities”, “Consulting engineers and architects” and “General contractors”. Some of the flows which cannot be explained by relatedness, e.g. the flow to “Mfr. of tiles, bricks, cement and concrete” in the case of Aalborg, can be explained by the industry being relatively dominant in the regional industry structure. For B&W there are large flows to “Refuse disposal and similar activities”, which can be explained by neither relatedness nor the local industry structure. The regional industry structure clearly affects the flows as expected. The flows from the shipyards are more strongly correlated with the local industry structure than with relatedness. The strongest correlation is found in the case of Nakskov, where the correlation of flows from the shipyard with local industry structure is 0.969 while the flows only exhibit a correlation of 0.707 with the relatedness index.

The indices of skill relatedness are used in the analyses to study the effect of skill relatedness on skill reallocation and destruction, cf. hypothesis 1.

4.2 Voluntary and involuntary mobility

Hypothesis 3 stated that, in general, voluntary job-to-job mobility should lead to skill reallocation while involuntary mobility should lead to skill destruction. We define the voluntarily mobile as those workers that re-enter employment the year after leaving the shipyard and which do not receive any unemployment benefits in that year. In addition workers fulfilling the former criterion, but who also have acquired a new education since leaving the plant are classified as involuntarily mobile.

Figure 3 in the appendix shows the pattern in which workers left each shipyard and the pattern in which they returned to work. The figure shows that Aalborg Værft and B&W were particularly abruptly closed down. And they show the consequences of the efforts by J. Lauritzen to reemploy their former workers in the cases of Aalborg Værft and Danyard Frederikshavn where relatively large shares were able to find a new job in the first year after leaving the shipyard. In order to investigate hypothesis 3 a dummy for voluntary mobility will be included in the analyses.

4.3 Spin-off workplaces

When a new workplace is added in the database it is marked as a spin-off if at least 30 per cent of employees have been transferred from another workplace. These workplaces are identified for each shipyard in year zero +/- 2 years. Spin-offs are only found in year 0 and year 0-1 except for Danyard, where there were also spin-offs in year 0-2. There are only a handful of spin-offs at each shipyard except for Aalborg. Most of the spin-off workplaces close down within few years and are thus not in the data when workers' status is recorded. Therefore working at a spin-off is defined as working at a firm to which at least one workplace was spun out from the shipyard regardless of whether the worker finds a job at the actual workplace that was spun out. The firm may or may not have existed before the shipyard closed down.

A dummy variable for working at a spin-off will be included in the analyses to investigate the effect on skill reallocation and destruction cf. hypothesis 4.

4.4 Explanatory variables

In addition to skill relatedness, voluntary mobility and spin-off variables workers are characterised according to ten variables: wage in the last year at the shipyard, gender, years of work experience when leaving the shipyard, years of unemployment before finding a new job, tenure at the shipyard, education when leaving the shipyard (two dummies), a dummy variable indicating whether education is higher when he re-enters employment, a dummy variable indicating whether he has moved to a new municipality since leaving the shipyard and a control for the size of the new workplace.

Hourly wage in the last year at the shipyard and the dependent variable, wage in the first year of reemployment, are both measured in year 2000 USD at PPP for all four shipyards. The information in IDA are in current DKK so the consumer price index has been used as deflator and the data then converted to USD using the average exchange rate for the year 2000 of 8.09 DKK/USD. We then use the World Bank PPP conversion factor for GDP to correct for differences in purchasing power.[4]

A dummy variable for female is used to control for gender. Years of work experience is a continuous variable in years. DST supplies values going back before 1980 so this variable is not constrained by 1980 being the first year in the database. Years of unemployment is the number of years before the worker again shows up in IDA with a valid estimate for hourly wage in addition to the year that must necessarily pass between observations. A worker may be involuntarily mobile but still have zero years of unemployment. As the database only goes back to 1980 the information on some workers will not allow for measuring tenure in excess of four years. Thus a dummy is used to indicate if workers had four or more years of tenure when leaving the shipyard. In the regressions there will be three categories of education: skilled, unskilled and higher education with skilled being the reference category. But the data contains more detailed information and when determining whether a worker re-enters employment with a higher level of education distinction will be made between: primary school, high school, business

[4] CPI and historical exchange rates are taken from DST at www.statistikbanken.dk. The World Bank PPP conversion factor to market exchange rate ratio for DKK to USD in year 2000 is 1.0. It can be obtained from http://data.worldbank.org/indicator/PA.NUS.PPPC.RF

college, professional education, 1-2 years tertiary, 3-4 years tertiary, 5-6 years tertiary and 7+ years tertiary education. Most of the workers that re-enter with a higher education move from one professional education to another. The size of the new workplace is measured by log full time equivalent employment. This variable is included to control for a possible size-wage premium (Oi and Idson, 1999).

Table 4 presents the shares for the categorical variables and mean, median and standard deviation for the continuous variables. The share of workers exhibiting voluntary job-to-job mobility is higher for Aalborg Værft than for the other shipyards. A relatively large share of workers from B&W and Nakskov moved their residence to a new municipality between leaving the shipyard and finding a new job. For B&W this is affected by the relatively small municipalities in and around Copenhagen while for Nakskov it probably reflects a depopulation trend for this peripheral region. Not surprisingly, the workers from the shipyards were mostly skilled workers with a large minority (20-30 per cent) of unskilled workers and very few with higher education. More than half of workers at B&W and Danyard had long tenure while less than half had long tenure at Aalborg and Nakskov. Finally, the share of women in the shipyards' workforce is small.

Table 4: Descriptive statistics

	Nakskov	Aalborg	B&W	Danyard
Observations	898	3,249	1,541	1,092
Categorical variables				
Voluntary	18.26%	48.23%	26.28%	34.62%
Spin-off	8.13%	21.36%	0.26%	5.86%
Moved	9.13%	5.88%	10.38%	5.68%
Higher education	0.89%	2.52%	2.08%	1.28%
Unskilled	21.16%	26.32%	29.27%	29.95%
New education	3.56%	5.48%	4.67%	2.29%
Long tenure	37.19%	31.15%	55.94%	62.36%
Female	5.35%	7.88%	4.93%	5.31%
Continuous variables				
$Wage^{New}$ (dependent)				
Mean	20.088	21.723	21.045	20.124
Median	18.370	21.460	19.558	19.073
Std.dev.	6.784	6.527	8.063	7.399
$Wage^{Shipyard}$				
Mean	18.837	20.963	22.928	22.425
Median	18.319	21.435	21.497	21.642
Std.dev.	4.487	6.128	7.879	7.379
Relatedness				
Mean	0.24	0.59	0.12	0.39
Median	0.21	0.82	0.14	0.48
Std.dev.	0.50	0.47	0.51	0.53
Experience				

Mean	13.37	12.56	14.33	17.79
Median	13.64	12.16	13.25	18.24
Std.dev.	6.42	6.63	8.66	8.58
Unemployment				
Mean	0.87	0.30	1.05	0.76
Median	0	0	1	0
Std.dev.	1.22	0.81	1.39	1.21
Size				
Mean	3.71	4.73	3.75	3.93
Median	3.70	4.75	3.93	4.04
Std.dev.	1.73	2.03	2.13	2.20

Shares reported for categorical variables. Wage in year 2000 USD at PPP. Experience and unemployment in years. Size is log FTE employment.

Mean wage at the shipyard and mean wage in the workers' new jobs are very close to each other, however they conceal that many workers experienced a decline in their hourly wage. This can be seen in Figure 4 in the appendix. Although the differences in mean hourly wages across the shipyards and between jobs at the shipyards and new jobs are small they do fit exceedingly well to expectations. For Aalborg and Nakskov the average mean wage for workers increased when they moved to a new job after the shipyard closed down. However, the median wage only increases very slightly indicating that a few workers did quite well after the closure and that the success of these people is affecting the mean. Mean wage at the shipyard was lowest at Nakskov, which was to be expected as it had a special agreement with the labour unions to set wages lower. The mean wages at B&W and Danyard were higher than Aalborg because these shipyards closed down 9-13 years later and the general standard of living in Denmark had increased. B&W has the highest wage level which can be explained by a generally higher wage level in Copenhagen than in the rest of Denmark. While the wage levels at the shipyards thus correspond to expectations, the mean wage in the new job is not higher for workers from shipyards that closed later (B&W and Danyard).

Workers at Danyard had somewhat more years of work experience on average than workers from the other shipyards. Average year of unemployment, for those that found a new job after the shipyard closed down, was shortest for workers from Aalborg, but median unemployment was zero years for all shipyards except for B&W. This indicates that the way the shipyards closed also matters and the hectic closure of B&W increased the extent of skill destruction.

Median relatedness of the industries in which workers from Aalborg Værft found their new job was 0.82 which indicates that the majority of workers found jobs in closely related industries. However, as the mean relatedness is 0.59, many workers found new jobs in unrelated industries. It seems that many of the workers from B&W found new jobs in less related industries, but with the low effort put into securing workers' jobs and the wide variety of jobs present in Copenhagen this is not surprising.

5 Regression on the extent of knowledge destruction

The following model will be estimated for each shipyard to test the hypotheses derived in Section 2:

$$Wage_i^{New} = \alpha_0 + \alpha_1 Wage_i^{Shipyard} + \alpha_2 Voluntary_i + \alpha_3 Unemployment_i + \alpha_4 Spin\_off_i$$

$$+\alpha_5 Moved_i + \alpha_6 Higher\_education_i + \alpha_7 Unskilled_i + \alpha_8 New\_education_i$$

$$+\alpha_9 Long\_tenure_i + \alpha_{10} Experience_i + \alpha_{11} Size_i + \alpha_{12} Female_i + \alpha_{13} Relatedness_i + \upsilon_i$$

The reuse of skills in the new job is approximated by the wage in the new job as discussed above. Hypothesis 1 stated that workers which find a job in a related industry will more often experience skill reallocation than destruction. This will be tested by the parameter α_{13}. Hypothesis 3 stated that voluntary job-to-job mobility will more often lead to skill reallocation than skill destruction. This will be tested by the parameter α_2. The parameter α_3 adds a bit more detail to hypothesis 3. If H_0: $\alpha_3 < 0$ cannot be rejected then involuntary job-to-job mobility does not only lead to more skill destruction but the effect is also aggravated by skills decaying during a spell of unemployment. Hypothesis 4 stated that finding a job at a spin-off company will more often lead to skill reallocation than skill destruction. This will be tested by the parameter α_4. Hypothesis 2 stated that the extent of skill reallocation or destruction depends on the presence of skill related industries in the region. It thus refers to effects at the regional level whereas the other three hypotheses refer to effects at the worker level. There will be no econometric test for hypothesis 2 except for the correlation in Table 6, but it will be argued below whether the four cases analysed here supports or refutes the hypothesis. All continuous explanatory variables are mean centred for the regressions to facilitate the interpretation of the intercept and the categorical variables.

Table 5 presents the result of estimating the model independently for each shipyard. $\hat{\alpha}_0$, the estimate for the intercept, is the expected hourly wage income in the first year of reemployment after leaving the shipyard for a worker, who earned the mean wage in the last year at the shipyard, was involuntarily mobile with the mean years of unemployment, did not work for a spin-off, did not move his residence to a new municipality, was skilled, did not acquire a new education, had short tenure and mean work experience and found a new job at a firm of mean size and the activities of which had mean skill-relatedness to shipyards. The estimated slope coefficients for $Wage_i^{Shipyard}$ (i.e. $\hat{\alpha}_1$) gives a rough initial idea of the extent of skill destruction all other things being equal. The highest estimate is found for workers from the former Aalborg Værft: 0.699. For each dollar of additional wage income at the shipyard the workers earned 70 cents in the new job. It can be interpreted as the closer the coefficient is to one, then more firm or task specific skills were reallocated while less were destroyed. Similarly, most specific skills were destroyed in the case of B&W, followed by Danyard and Nakskov.

Table 5: Regression results

	Nakskov			Aalborg			B&W			Danyard		
	Estimate	S.E.		Estimate	S.E.		Estimate	S.E.		Estimate	S.E.	
Intercept	19.870	0.295	***	20.887	0.159	***	20.470	0.337	***	20.360	0.380	***
Wage^{Shipyard}	0.687	0.098	***	0.699	0.049	***	0.529	0.059	***	0.585	0.037	***
Relatedness	2.168	0.344	***	1.632	0.259	***	2.838	0.367	***	2.605	0.410	***
Voluntary	0.727	0.574		0.977	0.175	***	0.666	0.409		1.066	0.403	***
Unemployment	0.302	0.169	*	0.647	0.107	***	-0.549	0.121	***	0.143	0.180	
Spin-off	0.721	0.688		1.492	0.276	***	-1.351	1.810		3.399	0.775	***
Moved	0.260	0.701		1.666	0.509	***	1.202	0.683	*	0.278	0.877	
Higher education	4.862	2.473	**	4.169	0.703	***	4.814	1.186	***	10.036	2.184	***
Unskilled	-0.434	0.482		-0.986	0.213	***	-0.761	0.350	**	-0.051	0.349	
New education	3.851	1.084	***	3.662	0.616	***	2.721	0.805	***	2.199	1.164	*
Long tenure	-0.081	0.498		0.044	0.214		0.471	0.385		-1.523	0.419	***
Experience	-0.027	0.038		0.003	0.014		-0.019	0.024		-0.024	0.024	
Size	-0.004	0.113		0.161	0.068	**	0.384	0.075	***	-0.358	0.106	***
Female	-1.045	0.744		-1.422	0.408	***	0.224	0.673		-0.641	0.655	
N	898			3,249			1,541			1,092		
R^2	0.27			0.51			0.40			0.45		

Independent OLS regressions. Asterisks denote the level of significance: *: 10% **: 5% ***: 1%. Dependent variable is hourly wage in year 2000 USD at PPP in first year of reemployment. Heteroskedasticity robust standard errors

The effect of voluntary mobility is positive and significant for Aalborg and Danyard. This supports hypothesis 3 that voluntary mobility leads to less knowledge destruction than involuntary mobility because workers that leave a firm for a new job voluntarily only do so when the new job is sufficiently attractive; i.e. when the new employer is able to re-use their skills. However, the larger the skill reallocation, as discussed above, the smaller the effect of voluntary mobility. In the case of Aalborg, where most of the specific skills were reallocated ceteris paribus, the effect of voluntary rather than involuntary job-to-job mobility is 0.65 dollars per hour, while it is 1.07 dollars in the case of Danyard where less specific skills were reallocated ceteris paribus. This pattern reappears throughout the table: the larger the skill reallocation, the smaller the economic effect of other variables. Unemployment is found to aggravate skill destruction for B&W, while it strangely is positive for Nakskov and Aalborg. This could be an effect of generally increasing real wages. The control for the size of the new workplace is positive for Aalborg and B&W, while it is negative and significant for Danyard. Thus, there is only an effect in the large cities.

Finding a job at a spin-off only had a positive effect in new wage income in the cases of Aalborg and Danyard. Very few workers from B&W found jobs at spin-offs, cf. Table 4, so it is not surprising that no significant effect is found. However, it is curious that there was no effect on wage income for the

workers from Nakskov of finding a job at a spin-off. The results indicate that mobility to a spinoff is skill reallocation and thus supports hypothesis 4.

A positive effect of relatedness is found in all four cases. The smallest effect is found for Aalborg where the skill relatedness has an estimated effect of +/- 1.63 dollars while the effect is +/- 2.61 dollars for Danyard. This effect of relatedness on skill destruction can't be neglected. Compared to the mean new wage (cf. Table 4) this is equivalent to about +/- 1.5 months' wages.[5] Thus, hypothesis 1 is supported.

The remaining estimates are more or less as could be expected though there are some interesting discrepancies across the four cases. The highly educated workers generally suffered less skill destruction than the reference, skilled workers. This is arguable an indicator that their skills are relatively adaptable and that higher education not only entails possession of skills but also signals the ability to learn and acquire new skills. The unskilled suffered more skill destruction than the skilled workers in the cases of Aalborg and B&W only. This indicates that the unskilled workers did relatively well in the cases of Nakskov and Danyard. Taking a new education is found to be positive in all cases and have a high impact on the hourly wage of between 2 and 4 dollars. There might be a self-selection effect since it can be easier for workers with high skills to take a new education, however, it could also be argued that this characteristic would have made it easier for them to move directly into a new job without getting a new education. The share of workers with a new and higher education ranges from 2.29-5.48 per cent which seems low. The positive effect of re-education indicates that there is room for a policy offering re-education to displaced workers when larges firms close down.

Moving residence only had an effect in the case of B&W and Aalborg. Former Aalborg shipyard workers moving to a new municipality before re-entering employment could expect to receive an extra 1.67 dollars per hour or 3,000 dollars of wage income in that year. Too much emphasis should not be put on the exact estimate as it is likely to be biased upwards by self-selection: workers moving residence are likely to be those with general skills that can be reemployed rather than destroyed. Despite this, it is interesting that the amount is still considerably less than the results of Dahl and Sorenson (2010), who estimate that choosing between two jobs where one is double the distance from home following a workplace closing would require a wage increase of 58 per cent.

Tenure has a negative effect in the case of Danyard only, while work experience does not have a significant effect in any of the cases. Tenure generally builds up firm specific skills so it was to be expected that it would have a negative effect. The fact that the negative effect is only found for Danyard may be caused by the imperfectness of the tenure measure (a dummy indicating whether tenure is four years or more).

[5] A working year is approximately 1,800 hours.

6 Conclusion

The analysis of the laid off shipyard workers shows that mobility of workers to related industries leads to less skill destruction. The effect is high ranging from +/- 8 to 14 per cent of the average wage in the new job. This result is robust and holds for all four shipyards even though they were closed down through different processes, were located in different regions and closed down in different years.

The voluntarily mobile displaced workers also experience less skill destruction, because they find a job that matches their current skills. It may be argued that voluntary mobility is endogenous to the model; that people who have skills that can potentially be reallocated are more likely to exhibit voluntary mobility. Similarly, it may be argued that taking a new education, finding a job at a spin-off firm, finding a job in a skill related industry, length of unemployment spell and moving to another municipality are all effects that are potentially endogenous. People with general skills that can be easily reallocated need to invest less effort into finding a new job. But people with more specific skills may have to move, have to take new education, search specifically for jobs in spin-off firms or related industries and may have to search for longer before finding a new job. People with relatively specific skills are also those that, all other things being equal, would experience the most skill destruction. Thus there is a risk that the effects of taking a new education, finding a job at a spin-off firm, finding a job in a skill related industry, length of unemployment spell and moving to another municipality are all underestimated in the present study. I.e. our estimates should be interpreted as conservative. The effect of voluntary mobility, on the other hand, may be overestimated. People with more general skills face fewer barriers to changing jobs and are thus probably more likely to be voluntarily mobile.

The presence of related industries in the region matters for the extent of skill reallocation and skill destruction, since labour mobility is geographically limited. This is in particular seen in the case of Aalborg where the workers generally experienced less skill destruction, measured as the partial correlation between wages in shipyard and new job. In the case of Nakskov the partial correlation is of a similar magnitude. However, the workers from the peripheral region around Frederikshavn that did manage to find a job in the same industry – shipbuilding, which was the ninth largest industry in the region even after the closure of Danyard Frederikshavn or in a related industry, also did well. Nakskov is also a peripheral region and the shipyard accounted for a large share of the employment, but the lack of related industries in the region resulted in skill destruction. Only 82 per cent of the workers find a job again, which is a lower share than in Aalborg and Frederikshavn (see Figure 3 in the appendix). The closure of a large company in such a region results in massive problems for the workers and skill destruction, but also leaves room for policy. However, the displaced workers from Nakskov that re-enter the labour market with a new education get higher wages. The positive result of a new education holds for all ship yards and suggests a policy of offering a new education to displaced workers from large company closure in a declining industry. The closure of B&W in central Copenhagen that offers a large and diverse labour market could lead to skill reallocation, but the median unemployment was higher than the other shipyards and only a small share ends up in related industries. The disorganised closure of the shipyard where the stakeholders fought each other rather than seeking to create or aid spinoff plants clearly added to the destruction of the displaced workers' skills in the region. The detailed analysis in Olesen (2012) of newspaper clippings, company reports and referendums from board

meetings from company achieves clearly shows that the closure of B&W was chaotic, while the closures of the other shipyards were also sudden, but more orderly. The closing of, in particular, Aalborg Værft provides a more successful story that resulted in skill reallocation, because the owner and other regional organisations and policy makers worked together to continue healthy parts of the company and to attract firms to hire the displaced workers. This is an important lesson for policy.

Other studies of displaced workers from declining industries or failing firms often find that most workers fairly quickly find a new job and therefore contrast the fear in public media and among policy makers that these events would lead to massive and prolonged unemployment. Our study also finds that most (82-91 per cent) find a new job within seven years, though most find the new job within the first two years (see Figure 3 in the appendix). Since many also retire, then the effect on the regional unemployment rate seems to be only temporary. However, our results show that finding a new job in an unrelated industry leads to skill destruction estimated as +/- 1.62 to 2.84 dollars per hour. This is likely to create large differences in life-time work income.

The shipyard industry was a declining industry in the period 1980-2000, but it did not disappear completely. However, the lack of opportunities in a declining sector is likely to increase the extent of skill destruction. The specificities of the sector also matters for the result: shipyards are mostly large firms, because it requires many workers with a wide range of skills in order to build a ship. Therefore, the closure of a large IT company might give the opportunity for smaller IT companies in the region to hire skilled workers or lead to a series of spinoffs that both would reduce the extent of skill destruction, which seems to have been the case for Intershop in Jena (Buenstorf and Fornahl, 2009). However, this result would be in line with our findings that finding a job in a related industry or at a spinoff company significantly lowers the extent of skill destruction for displaced workers.

The quality and knowledge of the regional workforce is often considered a cornerstone in regional innovation policy. Therefore the destruction of skills that happens when large firms close down also affects regional development. However, we do not know how the destruction and reallocation of skills really affects future regional industry diversification. Neffke et al. (2011) shows that the disappearance of an industry in a region could lead to the disappearance of related industries, but it is not clear how this process is affected by the skill destruction and reallocation from displaced workers. Future studies should address these issues.

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8 Appendix

Table 7: Aalborg Værft, Aalborg Functional Urban Region (FUR)

Rank	Share of redundant shipyard workers (per cent)		FTE employment in FUR (per cent)	Skill relatedness
1	Building of ships and boats	30.50	1.10	1.00
2	Mfr. of building materials of metal	22.71	2.29	0.82
3	General contractors	3.31	3.68	0.21
4	Consulting engineers and architects	2.82	1.02	0.31
5	Plumbing	2.50	0.91	0.60
6	Mfr. of tiles, bricks, cement and concrete	2.35	2.50	0.30
7	Mfr. of machinery for general purpose	2.27	1.55	0.64
8	Defence, police and administration of justice	2.27	2.86	0.27
9	Mfr. of machinery for industries	2.19	0.86	0.50
10	General public service activities	2.14	9.92	-0.41

Table 8: Nakskov Skibsværft, Lolland-Falster FUR

Rank	Share of redundant shipyard workers (per cent)		FTE employment in FUR (per cent)	Skill relatedness
1	Building of ships and boats	11.40	0.57	1.00
2	Mfr. of building materials of metal	11.18	0.95	0.82
3	General public service activities	7.67	10.52	-0.41
4	General contractors	7.45	2.15	0.21
5	Mfr. of other food products	5.54	5.23	0.08
6	Consulting engineers and architects	4.90	0.47	0.31
7	Mfr. of machinery for industries	3.09	0.94	0.50
8	Mfr. of rubber and plastic products	2.66	0.81	0.13
9	Mfr. of marine engines and compressors	2.66	1.42	0.69
10	Plumbing	2.24	0.64	0.60

Table 9: B&W, Copenhagen FUR

Rank	Share of redundant shipyard workers (per cent)		FTE employment in FUR (per cent)	Skill relatedness
1	Mfr. of building materials of metal	9.51	0.57	0.83
2	Building of ships and boats	5.34	0.04	1.00
3	General contractors	5.03	1.66	0.36
4	Refuse disposal and similar activities	3.79	0.68	-0.23
5	Install. of electrical wiring and fittings	3.73	1.04	0.53
6	Consulting engineers and architects	3.11	2.25	0.21
7	Mfr. of machinery for general purpose	3.05	0.45	0.50
8	Mfr. of machinery for industries	2.92	0.54	0.41
9	General public service activities	2.73	3.46	-0.74
10	Mfr. of marine engines and compressors	2.49	0.34	0.60

Table 10: Danyard Frederiskhavn, Vendsyssel FUR

Rank	Share of redundant shipyard workers (per cent)		FTE employment in FUR (per cent)	Skill relatedness
1	Building of ships and boats	25.67	2.55	1.00
2	Install. of electrical wiring and fittings	6.87	1.35	0.66
3	Mfr. of building materials of metal	4.98	0.60	0.83
4	Consulting engineers and architects	4.64	0.56	0.48
5	General contractors	3.00	2.28	0.31
6	Other construction works	3.00	0.36	0.59
7	Mfr. of computers and electric motors	2.92	1.12	0.53
8	Cleaning activities	2.49	0.47	-0.28
9	Mfr. of marine engines and compressors	2.40	1.68	0.54
10	Mfr. of machinery for industries	2.40	0.94	0.64

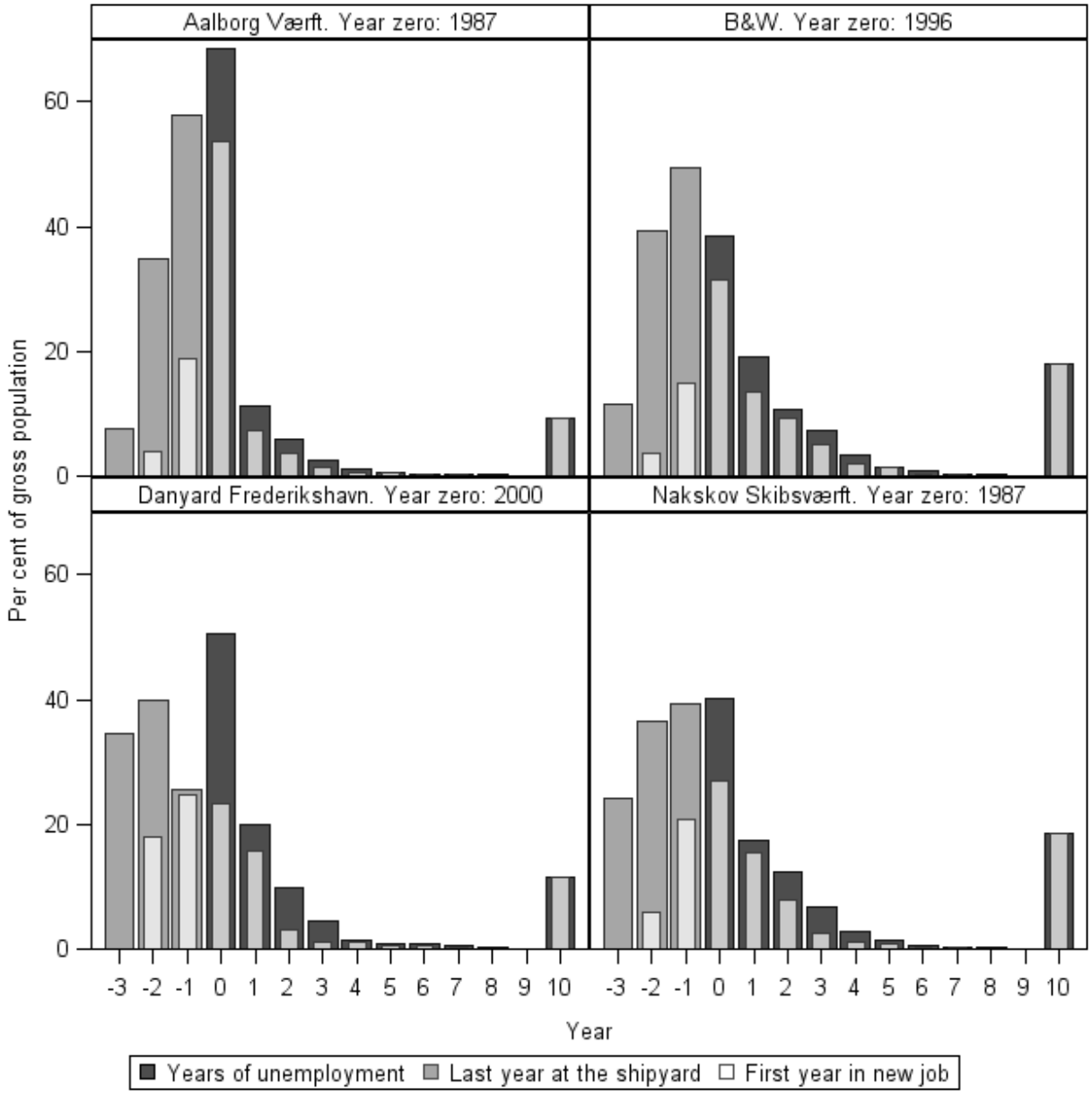

Figure note: The grey bars refer to the number of workers leaving the shipyard in that year. White bars are the number of workers finding a new job in that year. The all bars at year+9 take the value 0 for all shipyards. Year+10 are workers that never return. The black bars show the number of years of unemployment. Notice that the graphs include the entire gross populations; not just those used in the regressions.

Figure 3: Timing of leaving the shipyard and re-entering employment

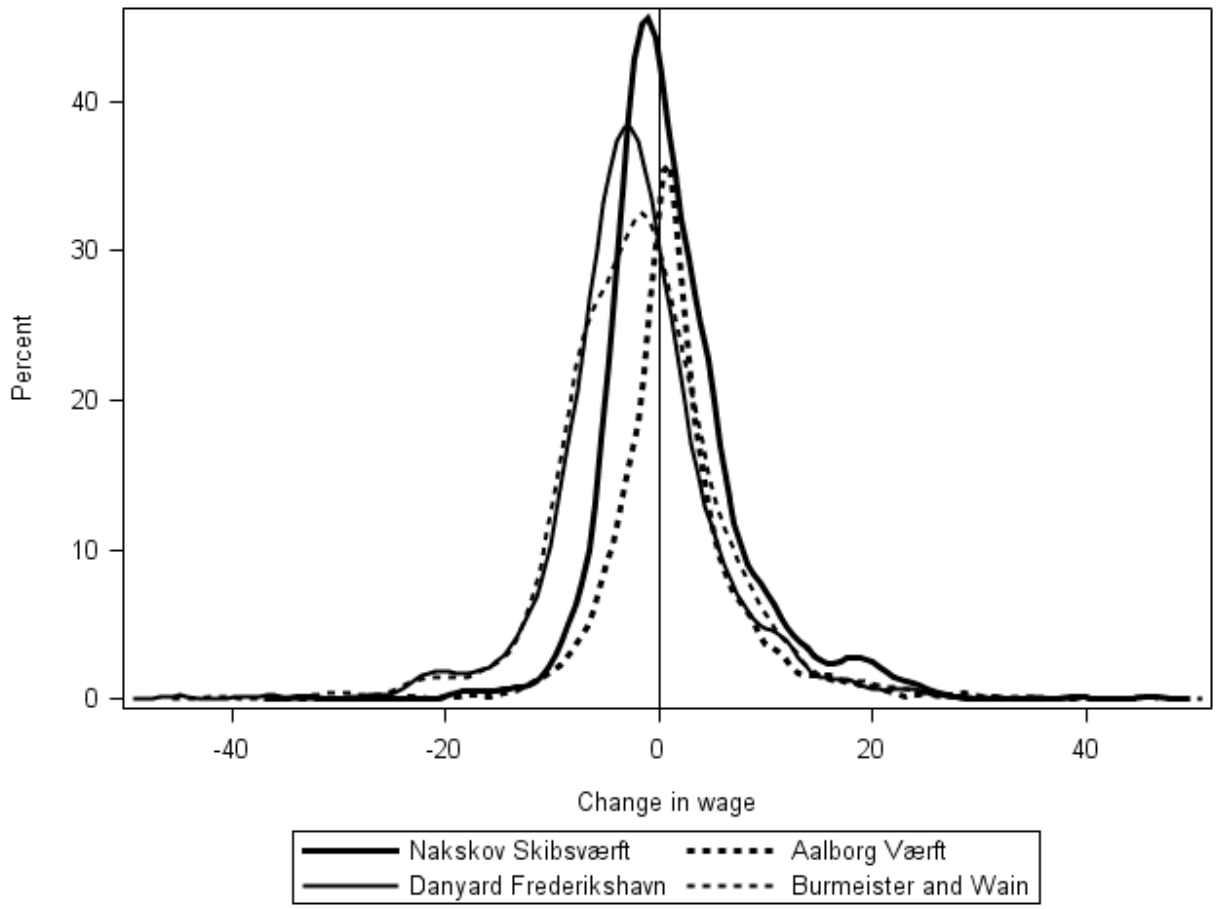

Figure 4: Difference in wage between shipyard and new job