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Firm survival and the rise of the factory

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Abstract

This paper uses longitudinal establishment-level data to trace the rise of the factory during Sweden's industrialization between 1864 and 1890. We document a sharp shift from the small artisan shop to the mechanized factory, which can largely be ascribed to differences in survival. Whilst non-mechanized establishments could compete with the factory during early industrialization, a distinct survival advantage of the factory appeared at later stages of industrialization. The evolving advantage of the factory can mainly be attributed to its larger scale, labour productivity, and technology use. By the end of the nineteenth century, these factors became increasingly important determinants of firm survival.

KEYWORDS
division of labour, factory system, industrialization, survival analysis, Sweden, technology

JEL CLASSIFICATION
L1, L2, N6

The factory was among the most consequential innovations of the industrial revolution. In the early nineteenth century, the vast majority of manufacturing was performed by artisans using hand tools to produce goods from start to finish. Yet by the end of the century, the locus of manufacturing had shifted to the large mechanized factory. Business historians led by Alfred Chandler have argued that the large-scale mechanized enterprise outcompeted traditional artisan shops. However, a revisionist literature emphasizes the scope for efficiency gains in the absence

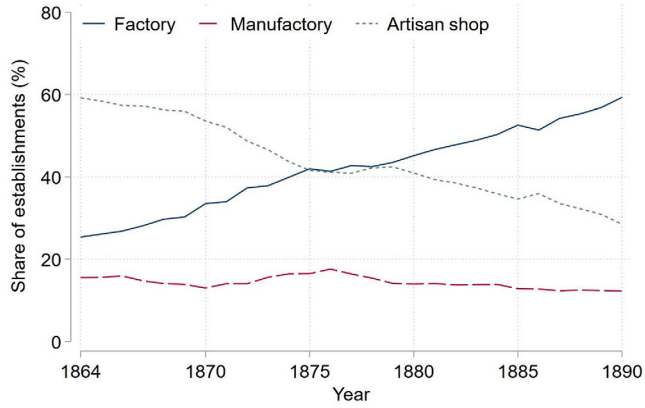

FIGURE 1 The rise of the factory, 1864–90. *Notes*: The figure shows the share of establishments included in *Fabriksberättelserna* organized as factories, manufactories, and artisan shops, respectively. Note that an establishment can switch between these categories over its lifetime. *Source: Fabriksberättelserna*. [Colour figure can be viewed at wileyonlinelibrary.com]

of mechanization, pointing out that the typical American or European industrial establishment remained remarkably small still on the eve of the First World War.[1]

Whilst a matter of great scholarly debate, there is a striking lack of quantitative evidence on how industrial organization shaped the performance of firms during industrialization. In particular, economic historians have emphasized the survival of firms as a key performance metric and termed it 'the ultimate "market test" of efficiency'.[2] Yet, we lack systematic empirical evidence on firm survival before the First World War due to the scarcity of longitudinal micro-level data.

Our paper uses newly digitized establishment-level data from the Historical Manufacturing Census of Sweden (*Fabriksberättelserna*), covering the country's rapid industrial take-off in the late nineteenth century. *Fabriksberättelserna* are among the world's oldest industrial censuses and were carried out annually from the mid-eighteenth century onward, containing detailed information on each establishment's workforce, production, ownership, and power sources.

We use our data to contrast the performance of three archetypal forms of industrial organization: the artisan shop, manufactory, and factory. The former two correspond to small and large non-mechanized establishments, respectively, whilst the factory is characterized by its reliance on inanimate power.[3] Figure 1 documents the rise of the factory during Sweden's industrialization. When the last remnants of the guild system were abolished in 1864, about 60 per cent of industrial establishments recorded in *Fabriksberättelserna* were organized as artisan shops. Yet by 1890, the factory had become the dominant organizational form: about 60 per cent of establishments – employing roughly 90 per cent of all industrial workers – were organized as factories.

[1] Evidence from the US Census of Manufactures, for example, shows that labour productivity in small manufacturing establishments was often higher than in larger establishments (Atack, *Estimation*; idem, 'Returns to scale'; Sokoloff, 'Was the transition'; Atack and Margo, 'Gallman revisited'). Also, in Sweden, the productivity advantages of large industrial plants were very slight, and small establishments had higher productivity than large plants in several industries (Jörberg, *Growth and fluctuations*, p. 152).

[2] Atack, 'Industrial structure', p. 37.

[3] As we describe in more detail below, we define factories by their use of an inanimate power source, that is, water and/or steam power. Artisan shops and manufactories are defined as establishments that do not report any use of inanimate power and employ less than or at least seven workers, respectively.

As a matter of accounting, the rise of the factory can occur along three margins. On the one hand, a growing share of new establishments may have entered as factories, or incumbent artisan shops or manufactories may increasingly have converted into factory form. On the other, factories could have survived relatively longer after entry. We show that newly established establishments were significantly less likely to be organized as factories compared with incumbents and that the conversion rate into factory form remained relatively constant during industrialization. Consequently, the rise of the factory must mainly be attributed to higher rates of firm survival.[4]

Our main empirical analysis examines differences in survival between artisan shops, manufactories, and factories. Estimating Cox proportional hazards models, we show that factories had a significant survival advantage relative to non-mechanized establishments: two decades after entry, about 40 per cent of factories remained in operation, which can be compared with about 15 and 30 per cent among artisan shops and manufactories, respectively. However, the survival advantage of manufactories relative to artisan shops suggests that some efficiency gains could be realized even without mechanization. In fact, when analysing how survival differences evolved, we find that manufactories exhibited similar survival rates as mechanized factories during early industrialization. The survival advantages of the factory arose only at a later stage of industrialization and primarily in modern industries.

Which underlying factors explain the higher survival rates of (manu)factories? Many studies emphasize the Smithian productivity gains due to the division of labour in larger establishments, which could partly be realized also in the absence of mechanization.[5] Another strand emphasizes the higher technological dynamism due to the use of inanimate power,[6] or the higher investments in innovative activity within large-scale enterprises.[7] Relatedly, some have argued that inanimate power enabled the substitution of machines and the cheap labour of children and women for male workers.[8] Others have instead emphasized that the spread of the large-scale factory was deeply intertwined with the emergence of the modern corporation that facilitated access to capital,[9] as well as the application of modern management practices.[10] A last explanation instead focuses on locational choices, as reflected in the shift of manufacturing production from rural to urban areas where the stiffer competition may have lowered the survival chances for smaller non-mechanized establishments.[11]

[4] We use the established term 'firm survival' throughout the paper, though our unit of analysis is the establishment. However, multi-establishment firms are relatively rare in our data and historical context, suggesting these terms can be used more or less synonymously (Berger and Ostermeyer, 'Institutional innovation').

[5] For example, Atack, 'Returns to scale'; Sokoloff, 'Was the transition'; Atack, 'Economies of scale'. Whilst the finding of earlier studies that economies of scale were exhausted at a relatively small scale is driven by certain assumptions made regarding the non-reporting of entrepreneurial labour (Margo, 'Economies of scale'), a more comprehensive source substantiates the presence of economies of scale for the industrializing United States (Atack, Margo, and Rhode, 'Mechanization takes command?').

[6] Landes, *The unbound Prometheus;* Jones, 'The rise'; Atack, Bateman, and Margo, 'Steam power'; Okazaki, 'Disentangling the effects'; Atack, Margo, and Rhode, 'Mechanization takes command?'

[7] Lamoreaux and Sokoloff, 'The decline'.

[8] Goldin and Sokoloff, 'Women, children, and industrialization'; eisdem, 'The relative productivity hypothesis'; Eriksson and Stanfors, 'A winning strategy?'.

[9] Rousseau and Sylla, 'Emerging financial markets'; Hilt, 'Corporate governance'; Atack, Margo, and Rhode, 'The division of labor'; Gregg, 'Factory productivity'; Artunç, 'Legal origins'.

[10] Landes, *The unbound Prometheus*; Chandler Jr., 'The competitive performance'; Nicholas, 'Clogs to clogs'.

[11] For example, Rosenberg and Trajtenberg, 'A general-purpose technology'; Kim, 'Division of labor'.

To tease out the role of these factors in explaining firm survival, we again estimate Cox regressions. We find that labour productivity, size, and technology use are key drivers of survival, whilst the corporate form or employment characteristics played a minor role after accounting for the fact that incorporated establishments and those that more intensively employed women and children were larger. Consistent with the fact that the survival advantage of factories emerged gradually, we find that the determinants of firm survival shifted over time. Whilst there is no clear association between size, technology use, and survival during early industrialization, both establishment size and the use of inanimate power are strongly associated with a lower risk of exit by the end of our period. Thus, whilst contemporaries such as Alfred Marshall and the early business historians led by Chandler were correct in arguing that the large-scale mechanized enterprise had a distinct survival advantage by the turn of the century, the advantages of the factory system seemingly appeared at a relatively late stage of industrialization.

I | DATA

Our data are drawn from the Historical Manufacturing Censuses of Sweden (*Fabriksberättelserna*), which have recently been digitized into a database covering the yearly performance of Swedish manufacturing establishments in the late nineteenth century.[12] The data were collected annually through forms sent out to manufacturing establishments. Establishment owners returned these forms to the local authorities, who summarized and sent the information to the Swedish National Board of Trade (*Kommerskollegium*), where the data were aggregated into the national industrial statistics. Whilst *Fabriksberättelserna* provide a unique opportunity to study the growth and development of industrial establishments during industrialization, the data also come with some well-known drawbacks. Most importantly, the Swedish industrial statistics exclude several industries that were regarded by contemporaries as belonging to the agricultural (e.g. dairies) and forestry (e.g. sawmills) sectors or as part of handicrafts (e.g. printing). Whilst the lack of coverage of some sectors remains a central challenge in accurately measuring Sweden's aggregate industrial activity, it is arguably less important when focusing on the comparative performance of establishments.[13] In particular, because the data were collected with relatively high uniformity for the period under study in our analysis,[14] *Fabriksberättelserna* provide an opportunity to examine survival patterns among the majority of establishments that would be considered part of 'manufacturing proper'. Moreover, it seems plausible that the differences in survival and its correlates that we document below apply also to those industrial sectors that remained outside the confines of the industrial statistics, given that the data include a wide range of industrial sectors similar in nature to those excluded.[15]

[12] See Almås et al., 'Historical Manufacturing Census of Sweden', and http://www.historicalmanufacturingcensus.se for more details.

[13] Several authors provide overviews of the Swedish industrial statistics, their use in historical national accounting, and evolution over time (Key-Åberg, 'Sveriges industristatistik'; Lindahl, Dahlgren, and Kock, *Wages, cost of living and national income*; Jörberg, *Growth and fluctuations*; Schön, *Historiska nationalräkenskaper*; Hamark and Prado, 'Modifying the success story'.

[14] Jörberg, *Growth and fluctuations*, p. 369.

[15] Similarly, artisans were recorded in a separate statistical census since *Fabriksberättelserna* historically pertained to 'factories and manufactories', which remained outside of the confines of guild regulations that regulated artisans. Contemporaries noted the fuzzy boundaries between artisans and the small artisan shops recorded in *Fabriksberättelserna*

Fabriksberättelserna give a detailed description of the inner workings of Swedish manufacturing establishments and contain annual information on employment, output, technology use, and ownership. To facilitate geographical comparisons over time, we assign each establishment to one of the 24 historical Swedish counties (*län*) shown in figure 4. The data are stored in separate ledgers for cities and rural areas, which we use to code an urban indicator. We standardize the reported industry of each establishment to conform with the official Swedish industrial classification of 1900,[16] which consists of 12 broad industry groups (figure 3) that are subdivided into 36 different industries. Because establishments sometimes report production spanning several industries, we assign each establishment its modal industry.[17] We use the information on the reported number of workers to measure establishment size. Whilst instructions to establishment owners were somewhat unclear, the number of reported workers generally corresponded to the average number of workers during the period that an establishment was active during a given year.[18] Owners were also instructed to separately report the number of male and female workers aged below and above 18 years. We use this information to identify establishments that intensively relied on child and female workers. To reduce the influence of measurement error due to establishments' failing to report disaggregated worker information in some years, we create two indicator variables that capture whether an establishment, on average across all years, reported a higher share of child and female workers, respectively, compared with the median establishment within its industry.

As a proxy for an establishment's labour productivity, we use reported information on the total sales value of output. Because we lack information on inputs and value-added shares, we construct a proxy for labour productivity following previous work.[19] For each establishment and year, we calculate the share of total output and the total number of workers within an establishment's industry. We then divide each establishment's share of output and workers, which yields a measure capturing whether an establishment exhibits relatively high or low productivity compared with other establishments within the same industry and year. Whilst this proxy for labour productivity is relatively crude, it adjusts for the fact that value-added shares differ considerably across industries and over time. Based on this measure, we create a set of three dummy variables that correspond to tertiles of the proxy for labour productivity, which we respectively term 'low productivity', 'medium productivity', and 'high productivity'. We also report robustness checks below where we include industry or establishment fixed effects (FE), which further adjust for differences in value-added shares across industries and establishments that remain constant over time.

We also use reported information on each establishment's steam and water power use. Because accurate information on horsepower is not available for the entire period under study, we focus

(Key-Åberg, 'Sveriges industristatistik'). However, whilst the lack of longitudinal data on the activity of artisans precludes a direct comparison, the prevalence of very small non-mechanized production units in *Fabriksberättelserna* suggests that our findings below regarding artisan shops may be informative also for the broader group of artisans.

[16] SCB, *Fabriker*.

[17] To do so, we use all observations for a given establishment and the period 1864–90. As further discussed below, we drop observations that could not be classified into the official Swedish industrial classification or denote closed establishments before assigning a modal industry. Industry controls generally refer to our 36 industries.

[18] Jörberg, *Growth and fluctuations*. The number of workers in establishments that are only active during some parts of the year, for example, due to seasonality, may be overstated relative to establishments operating year-round (Kommerskollegium, 'Tillfälliga', p. 30). We show below that our results are similar when controlling for industry fixed effects, which effectively absorb such between-industry heterogeneity.

[19] Jörberg, *Growth and fluctuations*; Kuznets, 'Quantitative aspects'.

on the extensive margin of technology use (i.e. whether an establishment report using any steam or water engine) that is measured with substantially less error.[20] As a measure of technological inventiveness, we identify establishments that obtained at least one patent in any year between 1864 and 1890, using data on the number of granted patents by the Swedish Patent and Registration Office.[21] Across our entire dataset, we identify 55 establishments that received a patent.

Each establishment also provides standardized information about its owners. First, the data contains information on the name of the establishment and that of its owner(s), as well as the number of owners reported as private persons (divided into male and female) and companies (*bolag*). We use this information to distinguish four types of ownership: (i) sole proprietorships (i.e. establishments that a single individual owned), (ii) partnerships (i.e. establishments owned by multiple individuals), (iii) companies (i.e. establishments with at least one company listed as an owner), and (iv) corporations. We use the information contained in the name of an establishment to identify whether it was owned by a corporation.[22] We complement this information using the Swedish incorporation registers from 1875 and 1881,[23] which allow us to verify the year of incorporation and identify some additional corporations.[24] In the case that information regarding the ownership was lacking, we assumed that establishments kept their previously reported type of ownership. If establishments did not report information on their ownership upon entry, we assume they are sole proprietorships.

Since the data do not contain an identifier tracing establishments across years, we use probabilistic matching methods to link establishments over time.[25] We link establishments in two steps.[26] First, we use the information on an establishment's name, the name(s) of its owner(s), geographical location, and industry to link establishments between years. Because the name of an establishment and its owner(s) may differ across years (e.g. due to differences in reporting or transcription errors), we calculate the similarity between names using Jaro-Winkler and Levenshtein edit distances. Jaro-Winkler and Levenshtein edit distances are measures bound between zero and one with a score of one indicating two identical strings (e.g. an identical owner name). We link two establishments across years if: (i) they are located in the same geographical location and are operating in a similar industry, (ii) they have highly similar establishment or owner names (i.e. a similarity score larger than the specified threshold of 0.9), and (iii) there is no other potential match according to these criteria. Second, we manually review links created by the matching algorithm. Using auxiliary information provided in the original forms allows us to correct faulty links and identify additional links not detected by the algorithm (e.g. a transfer of ownership of an establishment where the owner's name changed). Whilst, in many cases, we thus can account for ownership changes, the available information does not allow us to identify mergers. Thus, the

[20] Key-Åberg, 'Sveriges industristatistik'; Jörberg, *Growth and fluctuations*. If there is a gap in the reporting, we impute steam or water power usage.

[21] Andersson, Berger, and Prawitz, 'Making a market'. Patents awarded to firms denote the name of the firm on the patent records, which we manually link to the firm names recorded in *Fabriksberättelserna*.

[22] Jörberg, *Growth and fluctuations*, p. 197.

[23] van der Hagen and Cederschiöld, *Svenska aktiebolag med begränsad ansvarighet: 1848–74*; van der Hagen and Cederschiöld, *Svenska aktiebolag med begränsad ansvarighet: 1848–81*.

[24] If the name of an establishment contains any of the following terms, we identify it as a corporation: A B, AB, Aktie, Akt., Actie, Limited, and Ltd. If this procedure results in multiple possible years of incorporation, we use the earlier one and assume that establishments remain incorporated after this is first recorded.

[25] Abramitzky et al., 'Automated linking of historical data'.

[26] Almås et al., 'Historical Manufacturing Census of Sweden'; Ostermeyer, '*Why firms grow*'.

TABLE 1 Summary statistics

	All	Factory	Manufactory	Artisan shop
Establishment demographics				
Foundation year	1875.30	1876.46	1874.85	1874.09
Entry (0/1)	0.15	0.12	0.15	0.17
Exit (0/1)	0.08	0.06	0.07	0.11
Size and productivity				
Workers	24.88	43.68	23.47	2.77
Sales (1000s kr)	67.63	128.72	42.20	5.27
Sales/worker (1000s kr)	2.52	3.24	2.01	1.88
Relative productivity	0.90	1.00	0.87	0.80
Technology and innovation				
Steam power (0/1)	0.31	0.69	0.00	0.00
Water power (0/1)	0.16	0.36	0.00	0.00
Any patent (0/1)	0.01	0.02	0.01	0.00
Ownership				
Sole proprietorship (0/1)	0.69	0.52	0.66	0.90
Partnership (0/1)	0.02	0.02	0.02	0.01
Company (0/1)	0.14	0.18	0.20	0.07
Corporation (0/1)	0.15	0.28	0.11	0.02
Workforce characteristics				
Female workers (%)	14.33	16.76	19.34	8.93
Child workers (%)	11.56	11.84	16.83	8.81
Geographical location				
Urban (0/1)	0.58	0.55	0.78	0.53
Observations	17 406	7904	2969	6533
Establishments	2541	1226	609	1240

Notes: Summary statistics for our main analytical sample used in the survival regressions. We report the mean value of each variable. See section I for more details on the underlying data and sample restrictions.
Source: Fabriksberättelserna.

exit of a given establishment can denote both the ceasing of business activity or possibly a merger with another establishment, which then, in turn, would count as a new entrant. As described next, we limit our main sample to establishments that are observed every year from entry to exit (or the end of the period under study) where the linking algorithm is likely to perform better, and we provide several robustness checks to show that the linking approach is unlikely to drive our findings below.

Our main sample (see table 1 for summary statistics) is restricted to the years 1864–90, corresponding to the formative period of Swedish industrial development. To construct our analytical sample from the raw data, we first disregard two types of observations that were wrongly recorded: closed establishments (about 5750 observations) and establishments active in industries not contained in the official industrial statistics (about 230 observations). Throughout our analysis, we subsequently also drop establishments without a unique modal industry (about 1700 observations). Due to our empirical strategy and since our analysis distinguishes between small

and large establishments, we additionally drop about 9000 observations that do not provide information on the number of workers and disregard establishments that were active for only 1 year (about 2100 observations). Entry and exit are then defined as the first and last year, respectively, in which an establishment is observed. Because our data are available starting in 1863, we do not know the year of entry among establishments active before 1864. Therefore, our main empirical approach is restricted to establishments with an observed age. Additionally, we restrict our main sample to establishments that report a positive sales value for every year of their existence. We document in robustness tests below that loosening these sample restrictions (i.e. we include establishments that were only active for a year, have gaps in their reporting, and for which we cannot calculate an age) produces largely similar results. To give a more comprehensive account of Swedish industrialization, we also use this unbalanced panel for the descriptive figures and statistics in our analysis.[27]

II | TYPOLOGY: ARTISAN SHOPS, MANUFACTORIES, AND FACTORIES

A clear-cut operational definition of different forms of nineteenth-century industrial organization remains elusive.[28] We draw on previous scholarship to distinguish between small and large non-mechanized production units – artisan shops and manufactories, respectively – that we contrast with the mechanized factory.

First, we define factories as establishments that report using steam and/or water power. Arguably, the factory combined two distinct characteristics: a greater division of labour and reliance on inanimate power.[29] Since the former could also be realized in the absence of mechanization,[30] the defining characteristic of the factory is the use of inanimate power sources to mechanize production.[31] A typical example of modern factories were the vast steam-powered mechanical engineering establishments, such as Bolinders in Stockholm, employing hundreds of workers.

Second, we characterize establishments that lack a central inanimate power source by differences in size and implicit differences in the division of labour.[32] More specifically, we define artisan shops as establishments with fewer than seven workers and manufactories as those with seven or more workers.[33] A characteristic example of manufactories were the large tobacco establishments that could employ hundreds of workers but where cigars, cigarettes, and snuff

[27] Note that all variables that are measured relative to the industry level (e.g. productivity) are calculated for the specific sample used in the different tables.

[28] Atack, 'Industrial structure'; Mokyr, 'The rise and fall'.

[29] A third characteristic often emphasized is 'factory discipline', which has been seen as deeply intertwined with a reliance on inanimate power sources, at least since Marx. Whilst a matter of scholarly debate (e.g. Marglin, 'What do bosses do?'; Clark, 'Factory discipline'), the consensus view is that technological forces and factory discipline were intimately related (Landes, 'What do bosses'; Berg, 'Factories'; Jones, 'The rise'; Mokyr, 'The rise and fall'; Hudson, 'Industrial organisation').

[30] Sokoloff, 'Was the transition'.

[31] Schön, *Från hantverk*; Atack, 'Industrial structure'; Mokyr, 'The rise and fall'; Atack, Margo and Rhode, 'Mechanization takes command'.

[32] Nilsson and Schön, 'Factories in Sweden'; Laurie and Schmitz, 'Manufacture and productivity'; Berg, 'Factories'; Mokyr, 'The rise and fall'; Margo, 'Economies of scale'.

[33] Laurie and Schmitz, 'Manufacture and productivity'; Atack, 'Industrial structure'.

production was still carried out by hand with simple hand tools.[34] In contrast, the blacksmith shop is a paradigmatic example of an artisan shop where a master, perhaps with the aid of a few workers, produced a range of metal products from start to finish.[35] Admittedly, the exact size cut-off used to distinguish between artisan shops and manufactories is somewhat arbitrary. However, table 1 presents summary statistics for each type of establishment, revealing characteristic and informative differences (e.g. in terms of ownership and geographic location) between the two organizational forms.

III | THE RISE OF THE FACTORY IN SWEDEN: DESCRIPTIVE TRENDS

Around 1800, Sweden was a predominately agricultural and relatively poor economy on the European periphery. In the small cities and towns, manufacturing was carried out by artisans working under guild restrictions or in manufactories. The countryside was home to about 90 per cent of the population, where manufacturing was carried out by rural craftsmen working at a very small scale or within the confines of domestic industries.[36] However, after a range of liberal institutional reforms around the middle of the nineteenth century, Sweden experienced an accelerating pace of industrialization that was mirrored by the rise of the factory.

Figure 1 above shows that, in 1864 when the last remnants of the guild system were abolished, about 60 per cent of industrial establishments were organized as artisan shops. Yet by the 1880s, the factory had become the most common form of organization among industrial establishments.[37] However, when one turns to the number of artisan shops and manufactories in figure 2, it becomes clear that there was no dramatic decline. Figure 2 also reports the number of artisans (*hantverkare*) that were separately recorded in the Swedish industrial statistics. Whilst the number of artisan shops in *Fabriksberättelserna* declined by about 500 between 1864 and 1890, the decline was offset by a doubling of the number of artisans from about 10 500 to 22 000. Thus, the number of artisan shops, if anything, increased during industrialization,[38] and the rise of the factory depicted in figure 1 is mainly driven by a growing number of factories rather than the demise of artisans, artisan shops, or manufactories in absolute terms.

Factory organization made its first inroads in the textile industry in the first half of the nineteenth century.[39] Yet, figure 3 shows that mechanization also gradually spread to sectors such as food, wood, and paper. By the end of the nineteenth century, the factory had become the dominant organizational form also in 'modern' industries such as chemicals and machinery. At the

[34] Gårdlund, *Industrialismens samhälle*, p. 53.

[35] Atack and Margo, 'Gallman revisited'.

[36] Heckscher, *An economic history of Sweden*.

[37] Notably, these relative shifts conceal the importance of the factory when considering the distribution of employment across establishments, as most workers in *Fabriksberättelserna* were employed in factories already in 1864 (online appendix figure A.1).

[38] We report the number of artisans (*hantverkare*) but exclude apprentices and journeymen (*hantverksarbetare*) in figure 2, which means that the reported number of artisans should constitute a crude proxy of the number of shops. Indeed, in 1890, 22 344 *hantverkare* and 33 623 *hantverksarbetare* were recorded. The average artisan thus employed about 2.50 (55 967/22 344) individuals, which is similar to the average number of workers for the artisan shops recorded in *Fabriksberättelserna* (table 1).

[39] Schön, *Fran hantverk till fabriksindustri*.

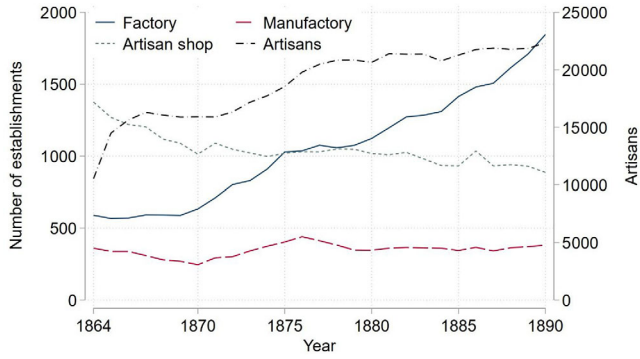

FIGURE 2 The rise of the factory, 1864–90. *Notes*: The figure shows the number of establishments included in *Fabriksberättelserna* organized as factories, manufactories, and artisan shops, respectively. See section I for more details on the underlying data and sample restrictions. On the right scale, the figure shows the number of artisans (*hantverkare*) according to the Swedish industrial statistics (SCB, *Fabriker*). As we exclude information on the number of additional workers and apprentices in such artisan shops, this statistic can be interpreted as the number of artisan shops in Sweden that are not covered in *Fabriksberättelserna*. *Source*: *Fabriksberättelserna* and SCB, *Fabriker*.
[Colour figure can be viewed at wileyonlinelibrary.com]

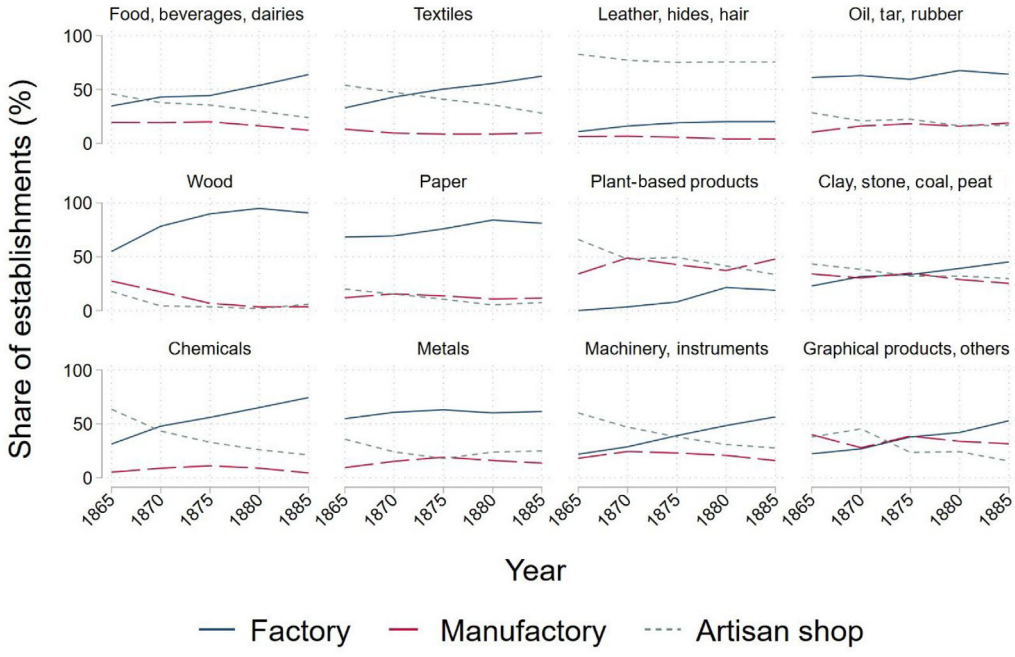

FIGURE 3 The rise of the factory across industries, 1865–90. *Notes*: The figure shows the mean share of establishments organized as factories, manufactories, and artisan shops, respectively, for each of the 12 broad industry groups and each 5-year period starting in 1865 through 1885. See section I for more details on the underlying data and sample restrictions. *Source*: *Fabriksberättelserna*.
[Colour figure can be viewed at wileyonlinelibrary.com]

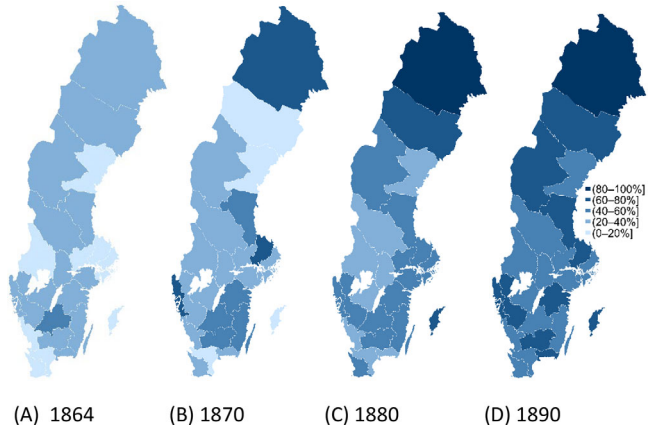

FIGURE 4 The rise of the factory by region, 1864–90. *Notes*: The figure shows the share of factories among all establishments in each region. See section I for more details on the underlying data and sample restrictions. *Source*: Fabriksberättelserna.
[Colour figure can be viewed at wileyonlinelibrary.com]

same time, artisan shops remained prevalent in 'traditional' industries such as leather, whilst manufactories remained central in, for example, plant-based products.

A peculiar feature of the breakthrough of the factory system in Sweden is that it largely took place in rural areas. About 50 per cent of factories and artisan shops were located in rural areas (table 1), whilst manufactories were primarily an urban phenomenon. Partly, the prevalence of mechanized factories in rural areas can be ascribed to the fact that many industries were rural in nature and to Sweden's ample endowments of water power.[40] Figure 4 shows that the breakthrough of the factory took place across virtually all regions of the country, mirroring the fact that Swedish industrialization, in contrast to other European countries, was associated with declining regional disparities.[41]

The high degree of rural industrialization, where markets were more limited, is also reflected in the persistence of small establishments throughout the nineteenth century. Indeed, whilst contemporaries were captivated by the rise of the large factory employing hundreds or thousands of workers, the median industrial establishment between 1864 and 1890 employed just about five workers (online appendix figure A.4B). Even the median factory and manufactory employed just about 15 workers still around 1890 (online appendix figure A.5B).

IV | ACCOUNTING FOR THE RISE OF THE FACTORY: ENTRY VERSUS EXIT

The compositional shift towards the factory can be attributed to three factors: entry, conversion, or exit. First, industrial entrepreneurs may have realized the advantages of factory organization and

[40] Prado, 'Yeast or mushrooms'.

[41] Enflo and Rosés, 'Coping with regional inequality'. Online appendix figure A.2 displays the regional concentration of industries. However, as shown above, the factory became the dominant organizational form in most industries, which is reflected in a declining regional concentration of factory workers and factories (online appendix figure A.3) despite differences in industrial specialization across regions.

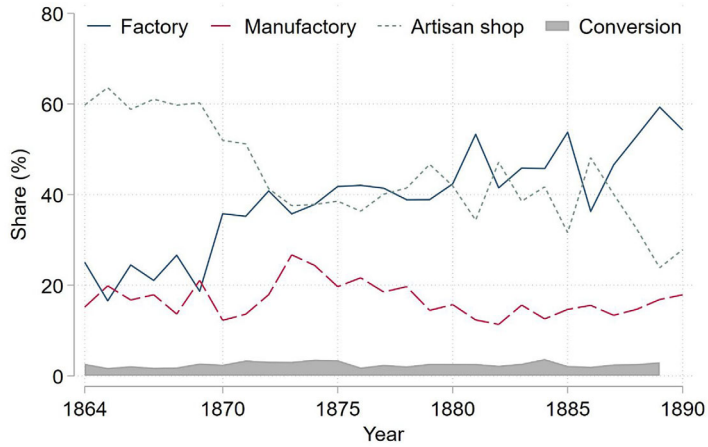

FIGURE 5 The organizational form of entrants. *Notes*: The figure shows the share among entering establishments that are either factories, manufactories, or artisan shops. At the bottom, it shows the share of incumbent establishments not organized as factories that became a factory in the next period. Note that – by construction – this variable has a missing value for 1890. See section I for more details on the underlying data and sample restrictions. *Source*: *Fabriksberättelserna*.
[Colour figure can be viewed at wileyonlinelibrary.com]

invested in inanimate power and large-scale production methods already at entry,[42] so that the share of entrants being organized as factories grows over time. Alternatively, the optimal organizational form may have been discovered in the process of active or passive learning after entry,[43] suggesting that establishments increasingly converted into factory form. Finally, factories may have exhibited lower exit rates – that is, higher survival – than non-mechanized establishments.

To disentangle the relative importance of these channels, we begin by comparing the characteristics of entering establishments with incumbents. Figure 5 shows that the share of entering establishments organized as factories increased from about 20 per cent in the 1860s to about 60 per cent in the 1870s and 1880s. These patterns are consistent with entrepreneurs learning to leverage new forms of business organization over time. However, to account for the compositional shift towards the factory, a larger fraction of entering establishments compared with incumbents must be organized as factories. To compare the organizational form of entrants to incumbents, we estimate simple ordinary least squares (OLS) regressions:

$$Y_{it} = \beta_0 + \beta_1 \, Entrant_{it} + \mathbf{X}'_{it}\beta_n + \varepsilon_{it}, \qquad \text{(Equation 1)}$$

where Y_{it} denotes the organizational form of an establishment i in year t, $Entrant_{it}$ is a dummy taking the value one in the year an establishment enters and zero for all other years, and X contains different sets of fixed effects.

Table 2 reports estimates of Equation 1. Column (1) shows that entrants were significantly less likely to be organized as factories than incumbents. Whilst the choice of organizational form may have differed across industries or across regions, the even-numbered columns of table 2 report estimates when including industry and county fixed effects, showing that differences in

[42] Lucas Jr., 'On the size distribution'; Hopenhayn, 'Entry, exit and firm dynamics'.

[43] Jovanovic, 'Selection'; Ericson and Pakes, 'Markov-perfect industry dynamics'.

TABLE 2 Establishment entry and organizational form

Dependent variable	Factory (= 1)		Manufactory (= 1)		Artisan shop (= 1)	
	(1)	(2)	(3)	(4)	(5)	(6)
Entry (= 1)	−0.028**	−0.063***	0.005	0.013*	0.023**	0.049***
	(0.012)	(0.010)	(0.009)	(0.008)	(0.011)	(0.009)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	Yes	No	Yes	No	Yes
County FE	No	Yes	No	Yes	No	Yes
Observations	17 406	17 406	17 406	17 406	17 406	17 406
Establishments	2541	2541	2541	2541	2541	2541
Mean dependent variable	0.454	0.454	0.171	0.171	0.375	0.375

Notes: OLS regressions. We run separate regressions of the stated outcome variables on a dummy taking the value one in the year an establishment is founded. We use our main analytical sample as defined in section I. Standard errors clustered at the establishment level are stated in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Fabriksberättelserna.

organizational form among entrants are more pronounced when controlling for unobserved variation across industries and regions. Furthermore, online appendix table A.1 shows that these patterns are similar throughout the 1860s, 1870s, and 1880s. Thus, the rise of the factory is not explained by an increasing share of establishments being organized as factories at entry.

Similarly, the rise of the factory is not driven by an increased conversion rate into factory form among incumbents. Figure 5 reports the share of incumbent artisan shops and manufactories that convert into factory form in the next year. About 3 per cent of incumbent non-mechanized establishments converted into factory form annually, and the rate of conversions remains constant during the period, suggesting that differences in survival must be central in explaining the rise of the factory.

V | FIRM SURVIVAL AND THE RISE OF THE FACTORY

Figure 6 displays the estimated share of establishments surviving up to a given age separately for artisan shops, manufactories, and factories. The median artisan shop and manufactory failed after about 4 and 9 years, respectively, whereas the median factory survived for about 13 years. Thus, whilst manufactories, on average, survived for longer than artisan shops, the factory had a distinct survival advantage relative to all non-mechanized establishments.

To substantiate these results, we estimate Cox proportional hazards models. Equation 2 is our main model to estimate the hazard rate $h(t|X_j)$ for a given establishment j where establishment-level exit is our censoring event:

$$h\left(t|X_j\right) = h_0\left(t\right) exp\left(X_j\beta_x\right) \quad \text{(Equation 2)}$$

The term $h_0(t)$ in Equation 2 states the baseline hazard of establishment-level exit, that is, the probability that an establishment exits when all independent variables X are equal to zero. Cox proportional hazards models are popular since they do not make assumptions about the shape

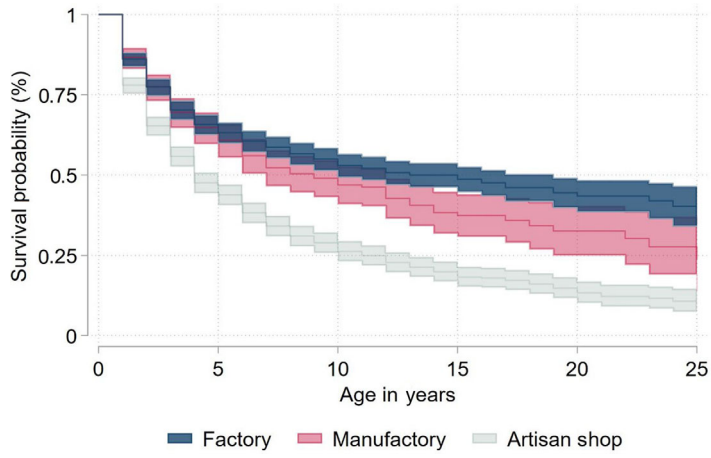

FIGURE 6 Kaplan–Meier survival curves. *Notes*: The figure shows the Kaplan–Meier survival curves and 95 per cent confidence intervals for factories, manufactories, and artisan shops, respectively. We use our main analytical sample as defined in section I. *Source*: *Fabriksberättelserna*.
[Colour figure can be viewed at wileyonlinelibrary.com]

of the baseline hazard. Instead, the model only assumes that it is proportional across establishments.[44] Of interest are the estimated hazard ratios for the covariates X_j, which are calculated by exponentiating the estimated coefficients β_x. To study whether survival was associated with the organizational form of establishments, we include dummies for factories and manufactories, capturing survival differences relative to artisan shops. Throughout, standard errors are clustered at the establishment level.

Table 3 reports estimates from Equation 2. We begin in column (1) by only including the dummy for factories. Factories were about 40 per cent less likely to exit relative to non-mechanized establishments, which is a sizable and statistically significant difference. In column (2), we include dummies for factories and manufactories, so artisan shops now form our reference category. Manufactories and factories were about 39 and 48 per cent less likely to exit compared with artisan shops, respectively.

As discussed above, entrants were less likely to be organized as factories, raising the question of whether it mattered for survival whether an establishment entered as a factory or converted into a factory after entry. Online appendix table A.2 presents estimates from Equation 2, where we include separate dummies for establishments that converted into factory form and establishments that were organized as factories already at entry. Whilst establishments that converted into factory form had a slightly lower exit risk, both types of factories had significantly lower exit risks than non-mechanized establishments. This is consistent with the observation that over time entrants

[44] One can test whether the proportional hazards assumption holds using Schoenfeld residuals. Effectively, this test uses regression analysis to identify possible relationships between the residuals and functions of time (Cleves, Gould, and Marchenko, *An introduction to survival analysis*, pp. 209–10). The assumption of a constant log hazard-ratio function over time implies that the regression of this test should have a slope of zero. Such tests can be done for the whole model and individual coefficients. The proportional hazards assumption seemingly holds on a global level when pooling the observations from all years in our most advanced specifications as well as when dividing the sample into decades. We further document that results are similar using an OLS approach below, which reduces concerns that potential violations of the proportional hazards assumption may drive our findings.

TABLE 3 Establishment-level survival advantage of (manu)factories

	(1) All	(2) All	(3) All	(4) All	(5) Urban	(6) Rural	(7) 1860s	(8) 1870s	(9) 1880s
Factory (= 1)	0.587***	0.516***	0.485***	0.510***	0.437***	0.622***	0.840	0.573***	0.413***
	(0.033)	(0.030)	(0.034)	(0.036)	(0.045)	(0.067)	(0.179)	(0.063)	(0.044)
Manufactory (= 1)		0.612***	0.566***	0.572***	0.508***	0.705**	0.632**	0.566***	0.568***
		(0.046)	(0.046)	(0.047)	(0.053)	(0.102)	(0.136)	(0.075)	(0.069)
Industry controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort controls	No	No	No	Yes	Yes	Yes	No	No	No
County controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14 865	14 865	14 865	14 865	8818	6047	1055	4551	9259
Establishments	2541	2541	2541	2541	1303	1242	431	1091	1775

Notes: Cox proportional hazards models. We use our main analytical sample as defined in section I. The final columns report estimates in subsamples for, respectively, the 1860s (1864–69), 1870s (1870–79), and 1880s (1880–90). We report exponentiated hazard ratios and standard errors clustered at the establishment level are stated in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Fabriksberättelserna.

converged with incumbents in terms of their organizational form, size, and technology use (online appendix figure A.6).

An open question is whether the survival advantages of the (manu)factory extended across all industries. Whilst the factory became the dominant organizational form in most industries (figure 3), the fact that the transition to factory organization differed across industries suggests that its relative advantages may also have varied.[45] To flexibly control for industry characteristics that might bias the estimated coefficients, we next add industry dummies in column (3), yielding a slightly larger survival advantage for manufactories and factories. To explore potential heterogeneity in survival rates across industries, online appendix figure A.8 reports estimated survival differences separately across our broad industry groups. Although the relatively small number of observations in some industries means that comparisons should be made with some care, the results suggest that factories survived relatively longer across industries. Moreover, our results seem broadly consistent with an interpretation that the advantages of the factory particularly appear in modern industries such as chemicals or machinery and instruments, whilst the advantages are less apparent in traditional industries such as leather or wood.

A related question is how the relative advantages of (manu)factories may have differed across regions and between rural and urban areas. Including controls for the 24 historical counties (*län*) of Sweden in column (4) does not appreciably affect the estimated survival advantages of (manu)factories. In columns (5) and (6), we split the sample into urban and rural establishments, respectively. Whilst both factories and manufactories exhibit higher survival rates in both types of locations, the relative survival advantage among (manu)factories is slightly larger in urban areas.

Lastly, we examine how survival differences evolved over time by estimating separate models for the three decades that span our sample period. Columns (7)–(9) show that the survival

[45] A related concern is that there might exist within-industry differences in the product mix of artisan shops, manufactories, and factories (Atack and Margo, 'Gallman revisited'). That is, survival differences could partly reflect the types of goods produced. A simple way to address these concerns is to examine survival differences within narrowly defined industries where all establishments produce homogeneous goods. Online appendix figure A.7 displays estimated survival differences within four narrowly defined industries where we generally find a large and similar survival advantage among (manu)factories.

advantage of factories emerged and overtook that of manufactories only over time. Yet, the finding that manufactories were more likely to survive compared with artisan shops suggests that some gains of the division of labour or economies of scale could also be realized in the absence of mechanization.

We provide several robustness checks in online appendix table A.3 to substantiate our findings. One concern is that our linking approach systematically links a lower fraction of artisan shops (e.g. because small establishments owned by a sole proprietor may lack a firm name in *Fabriksberättelserna*), potentially leading to an overestimation of their exit risk. However, when restricting the sample to establishments with 1–6 workers (i.e. a comparison of small factories with artisan shops) and 7–30 workers (i.e. a comparison of medium-sized factories and manufactories) in columns (2) and (3), we similarly find a distinct survival advantage of factories. This also holds in column (4), where we restrict the sample to establishments that have a unique and identical name in all years (i.e. where we only retain perfect matches).[46] Third, we show that the results of the Cox models are similar when using traditional OLS and fixed effects regressions, where we regress a dummy taking the value one when an establishment exits on dummies denoting the organizational form of establishments (online appendix table A.4).

VI | WHAT EXPLAINS THE SURVIVAL ADVANTAGE OF (MANU)FACTORIES?

Our results show that (manu)factories had a survival advantage relative to artisan shops. By definition, (manu)factories are larger and rely on inanimate power, which may partly explain their higher survival rates. However, artisan shops, manufactories, and factories also differ in several other dimensions. For example, whilst factories were larger and more productive, they were also more likely to patent and be owned by a corporation relative to non-mechanized establishments. Similarly, manufactories employed relatively more women and children and were more likely to be located in urban areas (table 1). Next, we estimate Cox proportional hazards models to examine the associations between a broad set of such establishment characteristics and survival.[47]

We first examine the association between the relative productivity of an establishment and the risk of exit. Column (1) shows a clear relationship between productivity and survival, with the most productive establishments being about half as likely to exit as the least productive ones. The association between productivity and survival is similar in column (8), where we include the full set of covariates, as well as a set of cohort, county, and industry dummies that capture survival differences that are common across time, regions, and industries.

We next consider the role of establishment size measured as a set of indicators for the number of employed workers: 7–15, 16–30, 31–50, and more than 50 workers. Table 4, column (2), shows that larger establishments saw a survival advantage, as evident from the fact that the risk of exit is significantly lower among all size groups relative to establishments with less than seven workers (the omitted reference group). The largest survival advantage is found for plants with more than

[46] Additionally, the fact that the survival advantage of factories relative to artisan shops was gradually realized over time suggests that systematic differences in linkage rates for artisan shops and (manu)factories are unlikely to drive our findings since survival differences due to differential linkage rates would be constant over time.

[47] Again, we corroborate the results of the Cox models using traditional OLS and fixed effects regressions in online appendix table A.5.

TABLE 4 Drivers of establishment-level survival

	(1) All	(2) All	(3) All	(4) All	(5) All	(6) All	(7) All	(8) All	(9) 1860s	(10) 1870s	(11) 1880s
Productivity											
Medium (= 1)	0.706***						0.791***	0.801***	0.753*	0.732***	0.888
	(0.042)						(0.049)	(0.049)	(0.112)	(0.071)	(0.084)
High (= 1)	0.559***						0.673***	0.668***	0.576***	0.626***	0.749***
	(0.038)						(0.048)	(0.048)	(0.102)	(0.069)	(0.080)
Size											
7–15 workers (= 1)		0.661***					0.679***	0.654***	1.098	0.687***	0.562***
		(0.048)					(0.052)	(0.052)	(0.235)	(0.089)	(0.068)
16–30 workers (= 1)		0.489***					0.516***	0.467***	0.652	0.465***	0.438***
		(0.049)					(0.057)	(0.055)	(0.273)	(0.089)	(0.072)
31–50 workers (= 1)		0.513***					0.567***	0.479***	0.445*	0.381***	0.460***
		(0.063)					(0.078)	(0.070)	(0.195)	(0.093)	(0.092)
Above 50 workers (= 1)		0.357***					0.407***	0.290***	0.531	0.194***	0.303***
		(0.046)					(0.060)	(0.049)	(0.240)	(0.060)	(0.070)
Technology and innovation											
Steam power (= 1)			0.567***				0.829**	0.886	1.617*	1.061	0.696***
			(0.038)				(0.062)	(0.075)	(0.449)	(0.135)	(0.083)
Water power (= 1)			0.680***				0.702***	0.742***	1.265	0.788	0.620***
			(0.055)				(0.060)	(0.068)	(0.340)	(0.115)	(0.089)
Any patent (= 1)			0.674				0.968	0.880	0.408	1.272	0.676
			(0.211)				(0.329)	(0.288)	(0.489)	(0.493)	(0.406)

(Continues)

TABLE 4 (Continued)

	(1) All	(2) All	(3) All	(4) All	(5) All	(6) All	(7) All	(8) All	(9) 1860s	(10) 1870s	(11) 1880s
Ownership											
Partnership (= 1)				1.175			1.572***	1.676***	0.959	1.790**	1.650*
				(0.203)			(0.273)	(0.286)	(0.603)	(0.436)	(0.429)
Company (= 1)				0.850**			1.070	1.121	0.722	1.055	1.245*
				(0.067)			(0.089)	(0.099)	(0.158)	(0.150)	(0.153)
Corporation (= 1)				0.537***			0.927	1.074	0.483	1.093	1.201
				(0.051)			(0.098)	(0.123)	(0.349)	(0.214)	(0.177)
Workforce characteristics											
High share women (= 1)					0.856**		1.078	1.045	0.897	1.014	1.150
					(0.052)		(0.068)	(0.073)	(0.188)	(0.115)	(0.119)
High share children (= 1)					1.047		1.289***	1.187***	1.058	1.394***	1.097
					(0.058)		(0.075)	(0.074)	(0.182)	(0.139)	(0.105)
Location											
Urban (= 1)						0.843***	0.934	0.712***	0.556***	0.684***	0.813*
						(0.043)	(0.051)	(0.052)	(0.122)	(0.080)	(0.091)
Industry controls	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Cohort controls	No	No	No	No	No	No	No	Yes	No	No	No
County controls	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Observations	14 865	14 865	14 865	14 865	14 792	14 865	14 792	14 792	1034	4540	9218
Establishments	2541	2541	2541	2541	2499	2541	2499	2499	418	1081	1756

Notes: Cox proportional hazards models. We use our main analytical sample as defined in section I. The final columns report estimates in subsamples for the 1860s (1864–69), 1870s (1870–79), and 1880s (1880–90), respectively. We report exponentiated hazard ratios, and standard errors clustered at the establishment level are stated in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Fabriksberättelserna.

50 workers, which have about a 64 per cent lower risk of failure. Again, the positive association between size and survival persists in more extensive specifications.

To examine the role of technology use and innovation, we include two separate indicators capturing whether an establishment reports using steam or water power. The hazards of exit are about 40 per cent lower for establishments using either steam or water power relative to non-mechanized establishments. We also consider the role of innovation by including an indicator for whether an establishment was granted at least one patent between 1864 and 1890. Whilst establishments that patented at least one invention were more likely to survive, this relationship is not statistically significant and is reduced when including the full set of variables and industry and county controls in columns (7) and (8). Yet, there remains a large and significant association with the use of inanimate power.

We next examine the association between ownership and survival. In column (4), we include separate indicators for establishments owned by partnerships, companies, and corporations, respectively, where establishments organized as sole proprietorships are the omitted reference category. Establishments owned by companies and corporations are significantly less likely to exit, with a 46 per cent lower exit risk among the latter. Partnerships are, if anything, more likely to exit compared with sole proprietorships. However, the survival advantages of companies and corporations disappear when including the full set of variables in columns (7) and (8), though a significantly higher probability of exit is evident among partnerships.

To examine whether establishments that intensively employed children and women were more likely to survive, we include two indicators capturing whether a plant employed a high fraction of women and children, respectively. The estimates in column (5) show that establishments employing relatively more female workers faced a statistically significantly lower risk of exit, though there are no significant differences in survival among plants that intensively relied on child labour. However, when including the full set of variables in columns (7) and (8), the estimates show that establishments employing a larger fraction of women and children, if anything, are more likely to exit.

Lastly, we examine the role of geographical location. In column (6), we find that establishments located in cities are less likely to exit. A lower exit risk among urban establishments is also evident in column (8) when including the full set of controls, which suggests that the urban environment contributed positively to survival, for example, due to agglomeration benefits.

Our results in the previous section showed that the survival advantage of the factory increased during industrialization. In the final columns of table 4, we examine whether the role of the establishment characteristics that we have examined similarly changed over the 1860s, 1870s, and 1880s. Notably, whilst productivity differences were a central determinant of survival throughout the period, the survival advantage associated with establishment size and the use of steam and water power only emerged over time. Column (9) shows that neither factor is significantly associated with a lower exit risk in the 1860s. Yet, as shown in columns (10) and (11), both size and the use of inanimate power become increasingly associated with a lower risk of exit by the end of our period.

VII | DISCUSSION

Our findings show that the rise of the factory during Sweden's industrialization can be attributed to the fact that it gradually gained a survival advantage compared with non-mechanized establishments. The survival advantages of the factory can largely be ascribed to the larger scale,

labour productivity, and technological dynamism realized under the factory system. In the final decades of the nineteenth century, these factors became increasingly important determinants of firm survival.

At the same time, our results suggest that survival advantages could also be realized among larger establishments, even in the absence of mechanization. Manufactories had substantially lower exit rates compared with artisan shops, and establishment size remains an important predictor of lower exit rates also when controlling for their use of steam or water power.[48] An ambiguous role of mechanization during early industrialization is consistent with arguments that managerial and technical skills were often in short supply,[49] and that the lack of standardized organizational knowledge in the wake of major technological shifts leads to many firms initially operating the new technology inefficiently.[50] Similarly, there is case study evidence that labour productivity in the textile industry could substantially increase even in the absence of mechanization, whilst mechanization often did not have any substantial positive effects on output per worker.[51] Whilst there is an influential argument that the division of labour was exhausted at a low level,[52] our results are overall consistent with more recent evidence, showing that both the division of labour and technology adoption were key drivers of productivity.[53]

Whilst the role of institutional innovations such as the limited liability corporation was deeply intertwined with the spread of the factory, we find little evidence that the corporate form directly impacted survival once we account for scale and technology use. Indeed, incorporation in Sweden during this period enabled establishments to expand their operations and promoted the adoption of steam power.[54] Thus, to the extent that the corporate form contributed to the survival advantages of the factory, it likely did so indirectly by enabling establishments to operate at a larger scale and by facilitating the adoption of new technologies.[55]

A similar conclusion holds for the role of child and female labour. Whilst establishments that intensively relied on children and women exhibited lower exit rates, these differences disappear once we account for differences in establishment size and the use of steam and water power. Thus, to the extent that manufactories and factories employing a high share of children or women exhibited a lower exit risk, this should be ascribed to the fact that these establishments operated at a larger size.

Together, these findings suggest that the survival advantages of the factory can largely be attributed to its larger scale and technology use. However, the role of these factors in shaping survival differences across establishments seems to have emerged with industrialization. Whilst large-scale mechanized establishments exhibited a lower risk of exit, the role of scale and the use of steam or water power became significant determinants of survival only in the 1870s and 1880s.

[48] An interesting observation is that the size of plants correlates with a longer survival also when controlling for productivity and technology. This suggests that size mattered for survival also through other channels than productivity. For example, larger plants may be more diversified, have access to greater financial resources, or have a larger pool of suppliers and customers, potentially contributing to their survival advantage.

[49] Jörberg, *Growth and fluctuations*, p. 152.

[50] Juhász, Squicciarini and Voigtländer, 'Technology adoption'.

[51] Schön, *Från hantverk*, p. 182.

[52] Sokoloff, 'Was the transition'.

[53] Atack, Margo, and Rhode, 'Mechanization takes command'.

[54] Berger and Ostermeyer, 'Institutional innovation'.

[55] Gregg, 'Factory productivity'.

These results thus underscore the finding above that non-mechanized manufactories were seemingly competitive during early industrialization and that the dominant role of the factory emerged at a later stage of industrial development.

VIII | CONCLUDING REMARKS

Our paper provides the first systematic evidence of firm survival during industrialization, drawing on new establishment-level data for Sweden during its industrial take-off. We leverage the longitudinal nature of the data to document that the rise of the factory mainly reflected the fact that factories, once established, tended to survive for longer than non-mechanized artisan shops or manufactories. By the late nineteenth century, the factory gained a distinct survival advantage that can largely be attributed to its greater size, productivity, and technology use.

Our results suggest that market competition increasingly favoured the factory, yet such market selection seemingly operated in a relatively slow way. By the end of the nineteenth century, the median industrial establishment still employed only about seven workers, and almost half of all establishments still did not rely on inanimate power. As observers summarized the state of Swedish industry at that time: 'old and new [lived] side by side; and the old dominated'.[56] These results are thereby similar to prior work leveraging data from the U.S. Census of Manufactures to document a striking persistence of relatively small establishments.[57] However, the longitudinal nature of our data shows that the puzzling persistence of the artisan shop at later stages of industrialization should not be framed as a question of why artisan shops survived for so long but rather why such a large fraction of newly established establishments continued to be organized as small artisan shops. Whilst about one in five factories emerged from previously existing artisan shops or manufactories, most artisan shops did not exhibit much growth and survived only for a few years. Interestingly, these patterns echo discussions about the lack of firm growth and persistence of establishments that are 'too small' in developing countries today.[58]

Our aim in this paper has been to provide a descriptive account of the rise of the factory during Sweden's industrialization and explore the role of internal factors such as establishment size, ownership structure, and technology in accounting for survival differences across establishments. However, we believe there is great value in using these data to examine further the role of external forces in shaping firm dynamics. In particular, at least since Adam Smith, the expansion of markets has been central to accounts of the rise of large-scale manufacturing. Indeed, evidence suggests that the widening of markets due to the coming of the railroad facilitated industrialization in Sweden,[59] whilst there is direct evidence that the spread of railroads contributed to the rise of the factory in America.[60] We will examine the role of market integration in shaping the entry, evolution, and exit of industrial establishments in future work. Ultimately, such a line of inquiry can further our understanding of barriers to industrial development that still persist today.

[56] Gårdlund, *Industrialismens samhälle*, p. 92.

[57] Sokoloff, 'Was the transition'; Atack, 'Firm size'.

[58] For example, Hsieh and Klenow, 'The life cycle of plants'.

[59] Berger, 'Railroads and rural industrialization'.

[60] Atack, Haines, and Margo, 'Railroads and the rise of the factory'.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study can be found in the first reference below.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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