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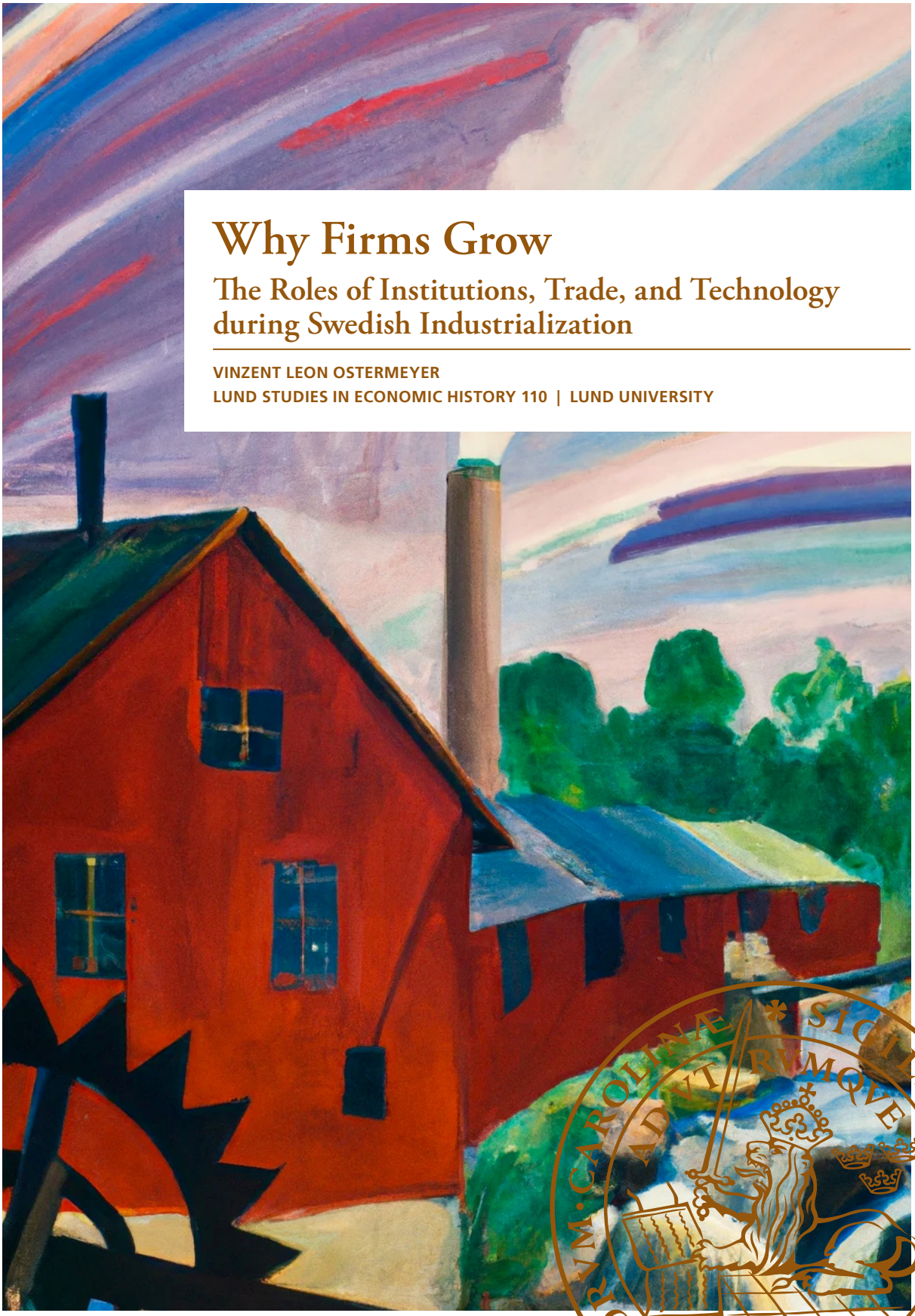

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Vinzent Leon Ostermeyer

LUND UNIVERSITY

DOCTORAL DISSERTATION

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Faculty opponent
Professor Markus Lampe

Why Firms Grow

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MADE IN SWEDEN

To my family

Contents

List of papers iii
Acknowledgements iv

Introduction **1**
1 Motivation and Contribution 1
1.1 Aim of the Study 1
1.2 Research Questions and List of Papers 7
1.3 Contributions 9
1.4 Limitations 14
2 Previous Research and Historical Context 15
2.1 The Second Industrial Revolution in a Global Perspective 15
2.2 Swedish Industrial Development 19
2.3 Industrialization through an Establishment-Level Perspective . . . 29
3 Data and Methodology 33
3.1 The Historical Manufacturing Census of Sweden—An Introduction 34
3.2 Definitions and Concepts 36
3.3 Linking Establishments over Time 38
3.4 Evaluating the Accuracy of Fabriksberättelserna 42
3.5 Other Data 47
3.6 Methodology 48
4 Findings and Results—Summaries of Papers 48
4.1 Firm Survival and the Rise of the Factory 48
4.2 Institutional Change and the Adoption of New Technologies: The Case of Steam 50
4.3 Winners and Losers: The Asymmetric Impact of Tariff Protection on Late-Nineteenth-Century Swedish Manufacturing Firms . . . 51
4.4 Local multipliers and the growth of services: evidence from late nineteenth century USA, Great Britain, and Sweden 53
5 Concluding Discussion 54
6 References 60
Appendix 82

The individual papers follow and have a separate numbering of pages.

List of papers

I **Firm Survival and the Rise of the Factory**

T. Berger, **V. Ostermeyer**
Unpublished manuscript

II **Institutional Innovation and the Adoption of New Technologies: The Case of Steam**
T. Berger, **V. Ostermeyer**
Unpublished manuscript

III **Winners and Losers: The Asymmetric Impact of Tariff Protection on Late-Nineteenth-Century Swedish Manufacturing Firms**
V. Ostermeyer
Accepted at *The Journal of Economic History*

IV **Local multipliers and the growth of services: evidence from late nineteenth century USA, Great Britain, and Sweden**
V. Ostermeyer
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Introduction

1 Motivation and Contribution

1.1 Aim of the Study

A key question in the social sciences is why some countries are rich, whereas others remain poor. Answering this question is highly relevant as today—despite massive improvements—every tenth person continues to live in extreme poverty (Roser, 2021). An influential argument maintains that economic growth and development are inextricably linked with processes of industrialization. Thus, without undergoing industrialization, economies generally have not managed to grow and, consequently, improve living standards (Amsden, 2001, pp. 1–2). Furthermore, a related stylized fact shows that it is not necessarily industry per se that drives economic development but specifically manufacturing. While the industrial sector is generally divided into mining, manufacturing, construction, utilities, transport, and communication, it was especially the expansion of manufacturing that drove the emergence of *modern economic growth* (Chandler Jr., 1990; Kuznets, 1971; Rodrik, 2016).

Expanding manufacturing—and, more generally, the industrial sector—is regarded as key to economic development for three reasons. First, it can absorb the large quantities of (unskilled) labor traditionally available in low-income countries. Second, it exhibits technological dynamism that enables economic convergence between countries. And third, manufacturing products are tradable so that producers are not fully dependent on local economic conditions such as small markets (Rodrik, 2013, 2016). Industrial growth is additionally heralded for its dynamic characteristics. Once industrialization is underway, it has the potential to create spillover effects, which drive growth in other sectors and, thus, broader economic development (Hirschman, 1958; Kaldor, 1967). The results of differences in the industrialization process across countries are reflected in Figure 1, showing that today's industrialized countries (Amsden, 2001, pp. 1–2) notice substantially higher living standards in terms of GDP per capita (in constant 2011 international $) compared to non-industrialized economies.

While GDP per capita and other aggregate statistics are useful to broadly sketch, for example, the evolution of living standards across countries, economic growth is ultimately

driven by firms.[1] Correspondingly, establishment-level inefficiencies and heterogeneity are often highlighted as key barriers for low-income countries to catch up economically today. While expanding especially the manufacturing sector is crucial to realize economic growth (Chandler Jr., 1990; Kuznets, 1971), industrialization in low-income countries often proceeds slowly. Consequently, large parts of the workforce remain trapped in low-productivity activities (Rodrik, 2013). This is exemplified by establishments in low-income countries generally remaining small and unable to grow, which contrasts the situation in high-income countries, where larger firms dominate markets (Mondragón-Vélez and Peña, 2010; Schoar, 2010). Moreover, resource misallocation across establishments is frequent and more extensive in low- compared to high-income countries, which reduces the aggregate total factor productivity (TFP). As such, improving the misallocation of resources across establishments in low-income countries to a level comparable to today's high-income countries would significantly boost their aggregate TFP (Hsieh and Klenow, 2009), which is ultimately driving per capita income (Hsieh and Klenow, 2010).[2]

Answers to why there are large gaps in economic performance today and how establishments can overcome constraints to growth also need to draw on history, as economies worldwide were generally poor and their (industrial) establishments small up until only a few centuries ago. As such, today's high-income countries around 1700 were not substantially richer than contemporary low-income countries (Figure 1). It was only during the following *First* and *Second Industrial Revolution* that some countries managed to industrialize. These processes set them on a path toward modern economic growth (Berg and Hudson, 1992; Clark, 2008; Crafts and Harley, 1992; Kuznets, 1973), which was characterized by the emergence of large(r) establishments (Chandler Jr., 1977, 1990). Consequently, understanding how establishments originally managed to start growing during this process deserves an explanation.

Several explanations for why some countries managed to industrialize have been proposed, stressing, for example, the development of relative factor prices (e.g., Allen, 2009a),

[1]In this thesis, a *firm* refers to the ownership structure of a business organization. As such, a firm can potentially own multiple business units, and a concrete unit of such business operation is called an *establishment*. My main aim in this thesis is to analyze the economic development of Swedish establishments during industrialization. Yet, to increase the general interest in this thesis, its title includes the term *firm*. Section 3 further discusses these topics. Overall, the distinction between firms and establishments is likely of minor importance to this study as historically, few firms owning multiple establishments existed in Sweden (Berger and Ostermeyer, 2022).

[2]Banerjee and Duflo (2019, pp. 188–195) discuss a telling example of resource misallocation across Indian textile firms. In the city of Tirupur, two types of T-shirt producers exist. While immigrants run some establishments, others belong to old and established families. Even though the establishments run by immigrants are more productive, in the absence of functioning capital markets, they cannot attract the necessary capital to grow and catch up with the less productive local firms. In turn, the local firms survive despite being less productive. Despite this example, it should be remembered that resource misallocation and establishment-level heterogeneity are not restricted to low-income countries. For example, Syverson (2004a) and Syverson (2004b) document sizable productivity differences among American establishments in narrowly defined manufacturing industries.

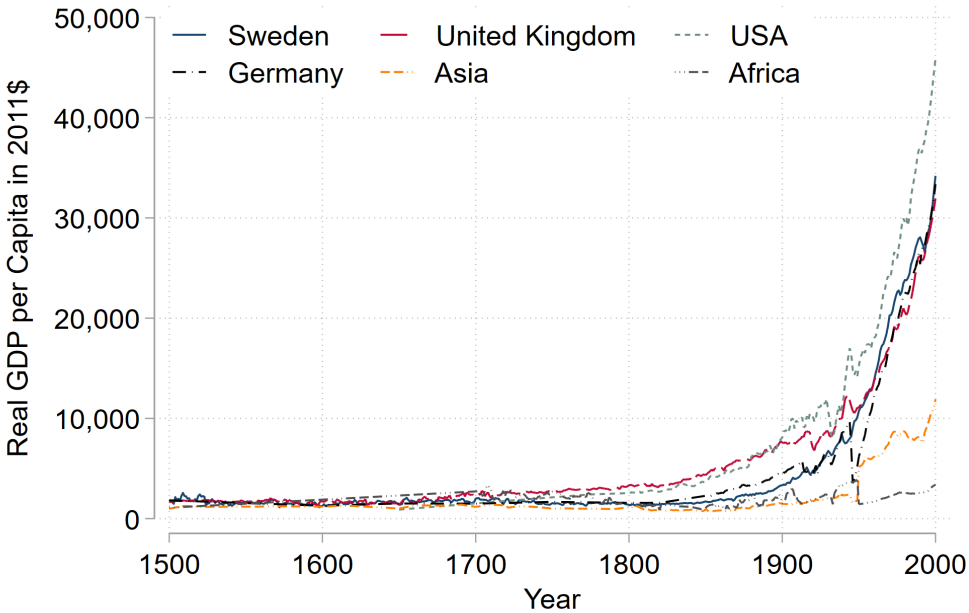


Figure 1: (Swedish) GDP per capita in an international perspective
Source: The data is taken from the Maddison Project (Bolt and van Zanden, 2020). For the displayed countries, the underlying historical data is published in papers by McKusker (2006), Sutch (2006), de la Escosura (2009), Pfister (2011), Schön and Krantz (2015), and Broadberry et al. (2015). The classification from Our World in Data (2015) is used to identify Asian and African countries.
Notes: The figure shows real GDP per capita in constant 2011 international $. The figure shows the mean GDP per capita across countries for Asia and Africa.

institutions (e.g., Acemoglu et al., 2005b), the spread of middle-class values (e.g., Clark, 2008), the advance of scientific knowledge and development of artisanal skills (e.g., Kelly et al., 2014, 2022; Mokyr, 2016), trade and economic integration (Persson and Sharp, 2015, pp. 173–188), geography (e.g., Pomeranz, 2000), and, specifically for the Second Industrial Revolution, industrial policy and scientific advances (Allen, 2011a, 2017).

While contemporary economic studies highlight that establishment-level heterogeneity is a fundamental determinant of differences in economic growth (Hsieh and Klenow, 2009, 2010; Rodrik, 2013; Syverson, 2004b), it is noteworthy that the outlined explanations for why industrialization (historically) occurred implicitly also stress establishment-level factors. For example, scientific advances were relevant as they could drive the development of new technologies, which were then applied in establishments. Consequently, the establishments—and in an aggregated sense, the economy—grew.

Yet, an explicit focus on establishments is largely absent in the literature that explains the historical processes of industrialization. While industrialization saw the rise of large-scale corporations (Chandler Jr., 1977, 1990)—i.e., the precursors to the large firms that

are characteristic of high-income economies today (Schoar, 2010)—the absence of appropriate data generally precludes studying how establishments achieved such growth during industrialization (Atack, 1985). Yet, it is relevant to answer such questions, especially for peripheral and late-industrializing countries. As these countries followed the industrial leaders of their time—i.e., Great Britain and the USA (Figure 1)—they were arguably in a similar position compared to today's low-income countries. As such, explaining how industrialization occurred at the establishment level has potentially broader implications than solely for understanding how growth historically emerged in single countries. This resonates with Gustafsson (1996, p. 223), who, after summarizing existing accounts for (Swedish) industrialization, concluded that "[t]here are still many empirical questions that remain unanswered. And the systematic rigorous causal analysis of the [industrialization] process is a still more difficult issue for future research."

This dissertation contributes to this research field by following a small but growing literature in economic history that leverages establishment-level data to study the channels through which industrialization proceeded. My focus is on Sweden, which was an important late-industrializing economy. By 1850, Sweden was still a relatively poor and agrarian country located on the European periphery Gustafsson (1996). Yet, the subsequent Swedish industrialization is generally seen as a success story as the country became one of the fastest-growing countries worldwide within the next five decades (Schön, 2012, pp. 82, 136–137). Thereby, understanding how Swedish establishments grew—or potentially failed to do so—not only adds to our understanding of Swedish economic development but offers broader insights into the channels underlying industrial growth. This is especially welcome as existing studies on historic establishment-level growth processes generally focus on the USA and, as such, on the leading economy of the Second Industrial Revolution (e.g., Atack, 1976; Atack et al., 2008; James, 1983; Sokoloff, 1984; Vickers and Ziebarth, 2018).[3] This research is enabled by the availability of new data in the form of the *Historical Manufacturing Census of Sweden* (in Swedish *Fabriksberättelserna*), which I helped to construct and make publicly available. As further discussed below, these data are unique as they give rich insights into the yearly performance of Swedish manufacturing establishments.

An example helps illustrate how establishment-level data are useful in uncovering the fundamental determinants of economic growth. While Sweden became a leading industrial economy between 1850 and 1900 (Figure 1), this occurred with substantial heterogeneity across establishments, which is (generally) not reflected in previous studies. For example, Figure 2 shows the shares of large and small establishments among all Swedish manufacturing establishments over the nineteenth century.[4] While a stylized fact is that industrialization saw the *rise of the factory* that employed a large number of workers and

[3]As Section 2 discusses, newer contributions also focus on other late-industrializing countries such as Imperial Russia (e.g., Gregg and Nafziger, 2020; Gregg, 2020), Egypt (e.g., Artunç, 2019, 2021) or Japan (Tang, 2014).

[4]While ultimately this definition is somewhat arbitrary, large establishments are here defined as having 20 or more workers, whereas small establishments have five or fewer workers.

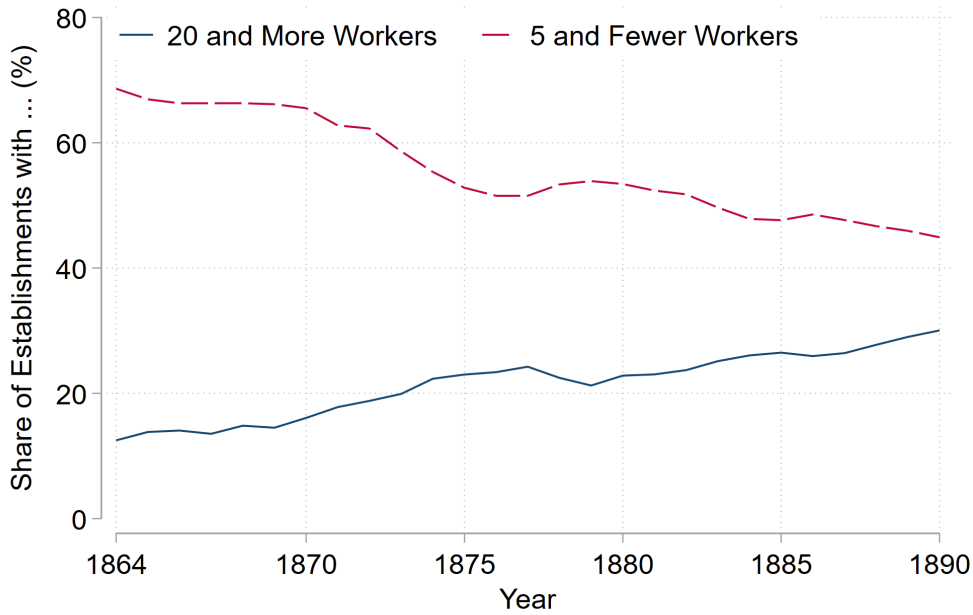


Figure 2: The evolution of establishment-level size during industrialization
Source: Fabriksberättelserna.
Notes: The figure shows the development of establishment-level size using the number of workers as a proxy. Specifically, it shows the yearly share of establishments employing 20 and more or five and fewer workers, respectively.

relied on mechanized production (Chandler Jr., 1977, 1990; Mokyr, 2001), the new data show that most industrial establishments were still surprisingly small by 1900. Thus, a first tentative insight is that (only) relatively few establishments managed to grow to a larger size. As they employed the majority of industrial workers (Appendix Figure A.1), it was them who ultimately drove economic growth.

Answers to why countries, such as Sweden, industrialized must, therefore, explain how some establishments managed to grow, whereas others did not. To do so, this thesis draws on previous accounts highlighting how establishments plausibly overcame constraints to growth. Yet, in the absence of establishment-level data, it has largely not been possible to empirically test such explanations (Atack, 1985). For example, a contentious debate concerns the role of the modern corporation in driving economic growth (Gregg, 2020; Guinnane et al., 2007; Jörberg, 1961; Robinson, 1952; Rosenberg and Birdzell Jr., 1986). Second, while technological change is key for long-run economic growth (Solow, 1956), new technologies such as the steam engine often diffuse slowly. Thus, understanding how establishments overcame barriers to technological diffusion becomes crucial (Crafts, 2004b; Hall, 2004; Hall and Khan, 2003; Mansfield, 1961; Rosenberg, 1972). By contrasting the evolution of two Swedish manufacturing establishments, Figure 3 shows how factors such

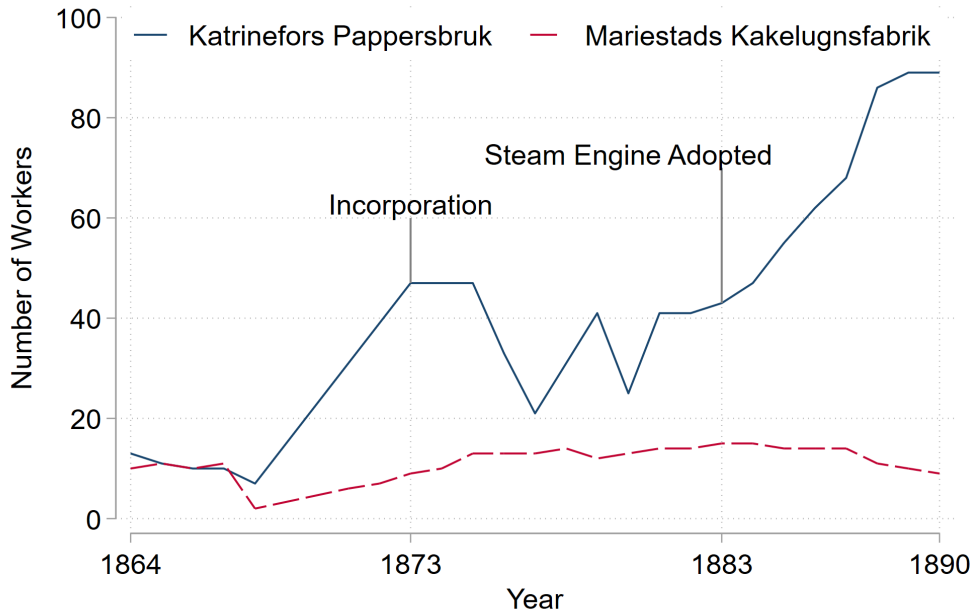


Figure 3: Establishment-level growth during industrialization
Source: Fabriksberättelserna.
Notes: The figure shows the number of workers employed by two Swedish manufacturing establishments. Katrinefors Pappersbruk was incorporated in 1873 and adopted steam power in 1883. Mariestads Kakelungsfabrik did not do either. Both establishments were located in Mariestad.

as institutional change and technology diffusion plausibly shaped establishment-level development and (ultimately aggregate) economic growth. Both establishments operated in the same place and were of similar size at the beginning of Sweden's industrialization process. Yet, while one establishment grew and saw about a sixfold increase in size, the other stagnated and was no larger in 1890 than in 1864. Ex post, it can be rationalized that this divergence was driven by one establishment, for example, incorporating and adopting steam power, which the other did not do. This thesis aims to formally test the explanatory power of such channels for economic growth.

This introductory chapter proceeds by first motivating the research questions posed in this thesis. It then sketches the theoretical frameworks used and gives a historical overview of (Swedish) industrialization. Here, I also relate my work to existing studies on establishment-level growth during industrialization. I next present the data used in this thesis and summarize my findings. Lastly, I provide a concluding discussion, which ties my findings together and puts them into a broader context.

1.2 Research Questions and List of Papers

To analyze the drivers of industrialization at the establishment level, this thesis is organized around three overarching research questions. First, this section states and motivates each research question. Second, it discusses how the respective papers address the research questions.

How did the organizational form of establishments affect their performance during Swedish industrialization? Industrial production took a variety of forms during industrialization. The general view maintains that during industrialization, production and work shifted from dispersed and small-scale cottage industries or artisan shops toward factories.[5] As such, a key characteristic of industrialization was the *rise of the factory* so that the share of establishments organized as factories increased (Chandler Jr., 1977, 1990). Yet, while this picture holds as a stylized fact (Mokyr, 2001), industrialization was also often characterized by the surprising persistence of small establishments (Atack, 1986, 1987; Berg, 1994; James, 1983; Sokoloff, 1984; Ziebarth, 2013), resembling the experience in today's industrializing economies (Rodrik, 2013).

Why factories (eventually) emerged as the dominant mode of production during industrialization is heavily debated, thus inviting empirical investigation. For example, while it has been maintained that size (e.g., Langlois, 1999; Okazaki, 2021; Sokoloff, 1984) and technology (e.g., Atack et al., 2008, 2022; Jones, 1987), as well as differences in management, ownership (e.g., Artunç, 2021; Gregg, 2020; Hilt, 2015; Landes, 1969), and the workforce (e.g., Eriksson and Stanfors, 2015; Goldin and Sokoloff, 1982, 1984), gave factories an advantage, the relative importance of each factor is difficult to assess. Using detailed establishment-level data such as Fabriksberättelserna, it becomes possible to open the black box of the advantages traditionally associated with factory production and study how factories eventually became the dominant form of industrial production.

Specifically, I follow, for example, Laurie and Schmitz (1981) and Atack (1985) by comparing the performance of factories—i.e., mechanized establishments using steam or water power—with, respectively, larger and smaller non-mechanized establishments. This enables me to chart the evolution of how (Swedish) establishments organized themselves in the late nineteenth century, showing how the factory eventually became the dominant mode of industrial production. The thesis shows that the rise of the factory was not driven by establishments entering as or converting into factories but by a relatively longer survival of factories relative to non-mechanized establishments. In turn, I show that factories derived their survival advantage from the gains associated with the mechanization of production and the division of labor. While these factors became increasingly important over time, it is important to highlight that the other outlined factors—e.g., workforce, management, or ownership characteristics—accounted for relatively small parts of the factory's survival

[5] In this context, a factory is generally defined as an establishment that relies on inanimate power to mechanize production (e.g., Atack, 1985; Laurie and Schmitz, 1981).

advantage. Yet, while the factory became the dominant form of industrial production, the results also show that many establishments remained small. This ultimately prompts the second research question.

What made some establishments grow and adopt new technologies, whereas others stagnated? The question of why countries industrialized needs to give an account of how some establishments within these countries originally managed to evolve from being small to large, for example, through the adoption of new technologies and development of new innovation processes as suggested by Figures 2 and 3. To answer this question, I focus on the role of incorporation and higher tariffs in driving such establishment-level developments. The choice of these factors is motivated by the fact that these policies have been credited as key drivers of the Second Industrial Revolution across countries (Allen, 2011a, 2017).

Late nineteenth-century Sweden was a relatively liberal economy where two important policy changes took place, which are also representative of similar developments in other countries. First, the Swedish state took a step back by introducing a liberal incorporation law that made the process of obtaining a corporate charter essentially equivalent to a simple registration. Presumably, this helped to overcome capital constraints faced by especially smaller establishments when, for example, installing steam power, which was the general-purpose technology of its time. However, whether such channels explain processes of industrialization is difficult to test given data limitations (Aldous et al., 2023; Atack et al., 2008; Gregg, 2020; Guinnane et al., 2007; Hilt, 2006; Jörberg, 1961; Robinson, 1952; Rosenberg and Birdzell Jr., 1986; Rosenberg and Trajtenberg, 2004). Second, after a long period of pursuing a relatively liberal trade policy, Sweden and other countries substantially raised their import tariffs in the closing decades of the nineteenth century (Persarvet, 2019; Schön, 2012). Since it is heavily debated whether this drove industrialization (Bairoch, 1972; Lampe and Sharp, 2013; Lehmann and O'Rourke, 2011; O'Rourke, 2000; Schularick and Solomou, 2011; Tena-Junguito, 2009), establishment-level data have the potential to contribute to these debates (Shu and Steinwender, 2019). Overall, I find that these two policies contributed to, especially, the development of marginal and initially low-productivity establishments, which allowed them to grow, adopt steam after incorporation, and notice a relative increase in their productivity after being given tariff protection. Yet, my findings also come with a warning for the design of development policies. Import tariffs were a double-edged sword, as initially high-productivity establishments saw a relative decline in their productivity after being granted tariff protection.

How did industrialization affect the service sector? While manufacturing and industrialization remain key for economic convergence between countries (Rodrik, 2013), productivity gains in the service sector enabled the USA to eventually overtake Great Britain around 1900 (Broadberry, 2006). Indeed, the early contribution of services to aggregate development is often disregarded (Broadberry et al., 2018), and it is often maintained that first industry and then services grew (Aghion et al., 2021; Kuznets, 1973). In contrast, a revisionist

picture shows that services grew alongside industry during the late nineteenth century and employed a sizable portion of the workforce (Broadberry et al., 2018). For example, about 40 percent of employment was in the service sector in Great Britain in 1911 (Lee, 1979, 1984). Despite that services became economically important earlier than often thought, there is disagreement on what caused services to grow (Crouzet, 1982; Lee, 1984; Mathias, 1969). Motivated by the *employment multiplier* framework developed by Moretti (2010) for the contemporary USA, I show that industrial growth had more wide-ranging and dynamic consequences than previously thought—and discussed in the first three papers—as it was a key driver for the expansion of services, too. Specifically, I show that the creation of—especially high-skilled—manufacturing jobs contributed to the subsequent growth of services. Here, I broaden the analysis by including the USA and Great Britain. As such, I also focus on countries other than Sweden.

Outline of the thesis: The three research questions are addressed in four self-contained but related papers, which are summarized in Section 4. Each paper also poses further research questions that are motivated in the respective places. Two of the papers are co-authored with my main supervisor Thor Berger, who was mainly responsible for the theoretical framing, whereas I was primarily responsible for the analysis.

Individual papers: The titles of the four papers are as follows:

I Firm Survival and the Rise of the Factory *(together with Thor Berger)*

II Institutional Change and the Adoption of New Technologies: The Case of Steam *(together with Thor Berger)*

III Winners and Losers: The Asymmetric Impact of Tariff Protection on Late-Nineteenth-Century Swedish Manufacturing Firms

IV Local multipliers and the growth of services: evidence from late nineteenth century USA, Great Britain, and Sweden

Figure 4 gives an outline of this thesis by stating its research questions, the employed theoretical frameworks to answer them, and its results. Arrows indicate how the different elements of the thesis relate to each other. Reading the figure from left to right shows the results and conclusions from the individual papers. In the vertical direction, the figure presents how the different papers relate to each other.

1.3 Contributions

This thesis makes several important contributions both to data as well as academic and methodological debates. This section briefly summarizes the most important contributions, which are further discussed in the respective papers. Additionally, Section 4 provides an

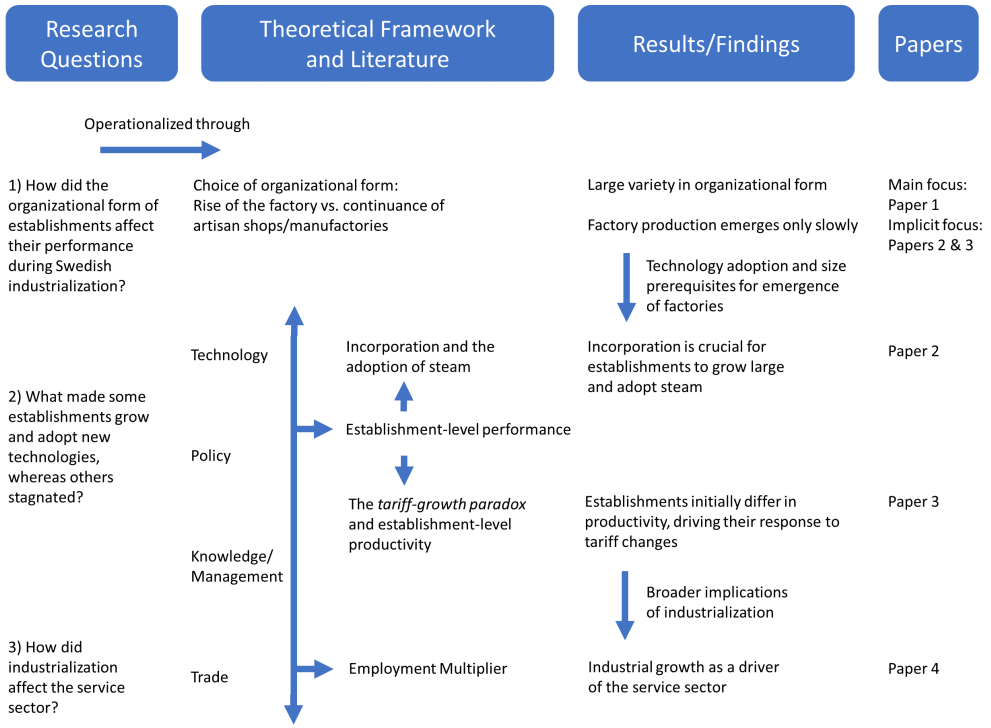


Figure 4: Outline of the thesis
Source: Own representation.
Notes: Arrows show the connections between the different elements of the thesis. From left to right, the figure summarizes the research question, theoretical framework, and results of each paper. In the vertical direction, the figure shows how the papers relate to and build on each other

executive summary of each paper. Section 5 presents the overarching conclusions of the thesis and discusses the societal relevance and implications of my findings.

1.3.1 Contributions to Data

Detailed data are necessary to study establishment-level growth patterns during industrialization. As further outlined in Section 3, such data exist for Sweden. The *Historical Manufacturing Census of Sweden* is a detailed data set tracing the performance of Swedish manufacturing establishments on a yearly basis between 1863 and 1900. These data were digitized within a larger research collaboration between the Institute for International Economic Studies at Stockholm University (IIES) and the Department of Economic History at Lund University, where the author of this thesis is located. This data set is now publicly available at https://www.historicalmanufacturingcensus.se.

As a project member, I have been involved in the creation of the data set from beginning to end. As such, I helped compile, clean, and harmonize—e.g., in terms of industry or location—the data. Additionally, I helped with quality checks of the data and (potential) revisions. Our joint paper (Almås et al., 2022) further outlines these aspects.

Within our project, my main contribution was to develop an algorithm enabling the tracing of establishments over time. This was necessary as the raw data do not contain a panel identifier, and Section 3 discusses this issue further. In turn, the ability to trace individual establishments over time enables me to apply econometric techniques that can causally identify the establishment-level drivers of growth. Overall, this approach also nicely complements existing establishment-level data for, for example, the USA, where establishments cannot be linked over time (Atack and Bateman, 1999). More broadly, I also contribute to data by harmonizing IPUMS census data (MPC, 2019; Ruggles et al., 2021) into sector-region-year cells across countries to study the dynamic effects of industrialization on the growth of services.

1.3.2 Contributions to Academic Debates

Besides its contribution to data, this thesis makes several significant contributions to academic debates. First, the Second Industrial Revolution has often been seen as the period where large-scale mechanized production—i.e., production in factories—triumphed (Chandler Jr., 1977, 1990), which ultimately outcompeted smaller establishments and led to the decline of artisans (Goldin and Katz, 1998). Yet, a revisionist literature highlights the flexibility of small-scale artisanal production (Berg, 1994; Sokoloff, 1984), documenting that there was no overall deskilling of the workforce (de Pleijt et al., 2020; Franck and Galor, 2017; Katz and Margo, 2014; Schön, 2012). Since my establishment-level data are linked and cover a substantial part of the late nineteenth century, I can disentangle the relative explanatory power of these competing accounts. In Paper I, we show that while the factory rose to become the dominant form of industrial production also in Sweden, artisan shops continued to operate to a sizable extent. Moreover, non-mechanized establishments leveraged substantial gains in survival by practicing a more elaborate division of labor. It was only as industrialization progressed that the relative advantage of the factory increased. More broadly, the finding that most establishments remained small resonates with similar results in low-income countries today (Schoar, 2010).

This finding also underscores the importance of technological change for (Swedish) industrial growth. While technological change is a key determinant of growth (Solow, 1956), the diffusion of new technologies can often only be studied at the aggregate level (e.g., Comin and Hobijn, 2010; Griliches, 1957; Hanlon, 2020) and is often surprisingly slow (Crafts, 2004b; Hall, 2004; Hall and Khan, 2003; Mansfield, 1961; Rosenberg, 1972). In Papers I and II, we study the diffusion of new technologies—i.e., water and steam power—at the establishment level. We show that adopting new technologies significantly raised the survival chances of establishments. As such, the findings underscore the importance of

particularly steam technology for industrialization and establishment-level growth (Atack, 1979; Atack et al., 2008; Rosenberg and Trajtenberg, 2004) and oppose studies questioning this (Crafts, 2004a,b; Prado, 2014; von Tunzelmann, 1978).

The first paper shows that most industrial establishments remained small throughout my analysis period.[6] Consequently, a key question is how (some) establishments achieved growth. As discussed above, state policy was an important lever to industrialize during the nineteenth century (Allen, 2011a, pp. 40–60, 78–83). Similar to other countries, a key objective of Swedish policy was to pass legislation aimed at broadly liberalizing the economy. This resulted in, for example, the removal of restrictions concerning market entry and the introduction of a system of general incorporation (Schön, 2012, pp. 92–94). These changes relate to an influential debate in economic history about the role of the corporation in driving economic development. While general incorporation laws provided the legal framework needed for large-scale enterprises to operate in Western countries around 1900, some argue that these laws followed and did not drive economic development (Rosenberg and Birdzell Jr., 1986, pp. 189–191, 207–213, 269–271). Similarly, it has been maintained that it is not possible to disentangle whether the ability to incorporate caused economic growth or vice versa (Jörberg, 1961, p. 260). Other scholars even find that the corporate form played a negative role in economic development (Hilt, 2006). Against this backdrop, recent evidence questions such claims as, for example, the corporate form allowed firms to expand in Imperial Russia (Gregg, 2020). The modern corporation is associated with faster growth also in cross-country studies, although such research designs often imply that the underlying channels remain unclear (Davis, 1905; Foreman-Peck and Hannah, 2015). I contribute to this debate by showing that the modern corporation was crucial for (Swedish) economic growth. Specifically, it enabled establishments to expand to a size where the usage of steam technology became profitable. While the ability to incorporate was restricted in Imperial Russia, arguably delaying the country's industrialization (Gregg and Nafziger, 2019, 2020), I find that general incorporation allowed especially marginal Swedish establishments to finance their adoption of steam power and expansions. While the corporate form is often thought to be mainly relevant for larger establishments (Guinnane et al., 2007), my findings demonstrate that the modern corporation was successful in promoting widespread industrialization. This resonates with a literature that emphasizes the uniqueness of Swedish industrialization as it occurred across all regions so that there was no major regional divergence as observed in other countries (Enflo et al., 2014b; Enflo and Missiaia, 2020; Enflo and Rosés, 2015).

Another key aspect of policy states pursued to industrialize was the imposition of higher import tariffs during the late nineteenth century. Previous research uses aggregate data across countries to study this question. However, the results are mixed regarding whether tariffs were successful in driving economic growth (Bairoch, 1972; Irwin, 2006; Jacks, 2006; Lampe and Sharp, 2013; Lehmann and O'Rourke, 2011; O'Rourke, 2000; Schu-

[6]See also Figures 2 and 9 in this introductory chapter.

larick and Solomou, 2011; Tena-Junguito, 2009). As this is potentially explained by tariffs heterogeneously impacting establishments (Shu and Steinwender, 2019), I provide a novel contribution by analyzing the establishment-level effects of tariff increases during the late nineteenth century. I show that tariffs had a heterogeneous impact across establishments as they benefited initially low-productivity establishments but hurt initially highly productive ones. Thus, I show that the effect of protectionism ultimately depends on the type of establishments that are active in a country, rendering the *tariff-growth paradox* (Clemens and Williamson, 2001) arguably less paradoxical.

As I further discuss in the concluding sections, my results show that state intervention—in the form of incorporation and tariffs—seemingly enabled especially marginal establishments to develop. Thus, policy was successful in creating widespread processes of industrialization. More broadly, this also contributes to contemporary economics as I show the usefulness of modern theoretical frameworks in explaining the historical processes of industrialization.

This thesis makes another significant contribution by documenting the channels through which industrialization had dynamic effects and drove broader economic development (Hirschman, 1958; Kaldor, 1967). As such, I demonstrate that industrialization was key to the emergence of the service sector. While economies recently shifted to being more oriented toward the production of services (Aghion et al., 2021; Kuznets, 1973), I contribute to a literature showing that services already became economically important during industrialization, which is often disregarded (Broadberry et al., 2010, 2018; Gemmell and Wardley, 1990; Hartwell, 1973; Rosés and Wolf, 2019; Weiss, 1967, 1971). Moreover, why a service sector emerged is heavily debated (Crouzet, 1982; Lee, 1984; Mathias, 1969). My fourth paper makes a key contribution to this literature by (i) explicitly acknowledging the importance of services already during industrialization and (ii) establishing the presence of one concrete channel leading to the growth of services. Consistent with contemporary dynamics (Moretti, 2010; Moretti and Thulin, 2013), I find that growth of (especially high-skilled) industrial employment created service jobs in local labor markets. Specifically, I estimate that each additional industrial job created up to one additional service job. The creation of high-skilled industrial jobs drives this effect with the creation of up to two local service jobs. While such dynamics are proposed to explain the emergence of services in single cases (e.g., Crouzet, 1982; Mathias, 1969), I substantiate them across a larger group of countries, using a consistent empirical approach. Specifically, I focus on the USA, Great Britain, and Sweden, for which I harmonize IPUMS census data (MPC, 2019; Ruggles et al., 2021) at the regional, sectoral, and skill levels. This also improves upon contemporary studies that (generally) estimate employment multipliers for single countries (e.g., Moretti, 2010).

More broadly, by focusing on selected policies, my thesis also contributes to a growing literature on the empirics of industrial policy. Recently, it has been highlighted that while there is a general (political) interest in evaluating the effectiveness of industrial policies, traditional approaches that mostly use cross-country regressions are unable to adequately trace

the channels through which industrial policy impacts economic development. In contrast, this can be remedied by micro-level approaches that leverage, for example, variation within countries, industries, or firms (Lane, 2020). Papers II, III, and IV focus on the effectiveness of selected industrial policies and document the channels through which they affected economic development. Thereby, the thesis highlights the usefulness of economic history in informing us about current economic issues. As industrial policy is complex, assessments regarding its effectiveness need to be nuanced (Lane, 2020). My papers reflect this as they highlight how establishments managed to develop under selected industrial policies, while also emphasizing—potentially unintended—negative consequences of such policies. In any case, by relying on establishment-level data, my study sketches the channels through which industrial policy operates, which is needed to properly understand its effectiveness (Lane, 2020).

Finally, my thesis can be seen as following a natural sequence relative to previous research on industrialization. While early studies mainly looked at aggregate national trends (Crafts, 1983; Crafts and Harley, 1992; Deane and Cole, 1962; Schön and Krantz, 2015, e.g.,), subsequent studies focus on differential growth rates across industries (Broadberry et al., 2011; Harley, 1982; Prado, 2014) or regions (Enflo et al., 2018; Enflo and Rosés, 2015; Pollard, 1981; Rosés and Wolf, 2018). With my establishment-level focus, I add a novel layer to this research field that enables me to study the channels through which growth occurred. Finally, as the *Credibility Revolution* in economics has over the last decades given researchers the tools needed to plausibly identify causal effects from observational data, this study follows a broader trend in economic history (e.g., Acemoglu et al., 2001; Donaldson and Hornbeck, 2016; Juhász, 2018) by leveraging quantitative data and the corresponding econometric techniques to identify causal effects.

1.4 Limitations

Naturally, this thesis has several limitations that should be considered when interpreting the findings and results. This section discusses the general limitations of this thesis, while each paper further outlines a smaller set of specific limitations.

As Section 3 discusses in more detail, this thesis mainly draws on the Historical Manufacturing Census of Sweden as its primary data source. While these data provide me with an in-depth look into the performance of Swedish manufacturing establishments, they also have limitations, which this thesis naturally inherits. Most importantly, this concerns their definition and coverage of (Swedish) manufacturing industries. Essentially, my definition of industry is based on which business activities enumerators considered industrial when collecting the data in the late nineteenth century. However, industrialization entailed the creation of entirely new activities so that the statistics and the covered industries were gradually expanded. One implication of this circumstance is that my data are, by design, not primarily informative for national accounting. However, as this is not my interest, this drawback does not affect this study. Instead, I aim to analyze changes within establish-

ments. And for that purpose, my data are appropriate, as Section 3 shows. Moreover, the addition of new industries is limited during my period of analysis, so changes in the underlying data are not driving the finding. Additionally, the addition of industries would only be problematic if establishments in industries that are currently not surveyed behave differently from establishments in industries that were covered. Overall, as my data contain information on industries relevant during the Second Industrial Revolution, I can, despite such limitations, draw broader conclusions about Swedish and international economic developments.

Relatedly, since my data are unique in detail and coverage, I have chosen a quantitative approach. Where applicable, I complement this with qualitative evidence in the respective papers, for example, by drawing on reports from contemporaries. Similarly, the introduction sketched the evolution of selected establishments in more detail.

Again necessitated by the available data, this thesis is mainly concerned with analyzing developments within the Swedish manufacturing industry and does not focus on, for example, interactions of the industrial with the agricultural sector. However, this is remedied in Paper IV, which analyzes the linkages between different sectors during industrialization. More generally, it can also be argued that this thesis mainly takes a supply-side perspective, as it analyzes how selected policies impacted establishment-level growth dynamics. As such, it places less emphasis on how the demand side of the economy contributes to establishment-level developments. Yet, Paper IV—with its primary focus on multiplier effects—provides a qualification. Specifically, by analyzing how industrial growth increased the demand for and, ultimately, raised the number of workers in services, I balance the general supply-side view of this thesis with a demand-side perspective. Generally, the aim of this thesis is not to take a normative stance on both views.

2 Previous Research and Historical Context

This section places the thesis in its historical context and summarizes previous research. Specifically, it outlines existing explanations for why countries industrialized before sketching how Sweden became one of the fastest-industrializing countries worldwide. It also relates the data used in this thesis to existing research that uses historic establishment-level information. Overall, the section demonstrates that establishment-level data are necessary to understand the channels through which industrialization proceeded.

2.1 The Second Industrial Revolution in a Global Perspective

The First Industrial Revolution in the eighteenth century was a turning point in the history of human development. While previously humans lived under the constraints of the Malthusian trap—i.e., any increases in material living standards translated into population growth, which decreased living standards again—Great Britain became the first nation to notice sustained economic growth. Why Britain industrialized first is a heavily debated

question and different explanations have been put forward: (i) *Relative factor prices*: comparatively high wages with simultaneously low energy and capital costs were conducive for labor-saving technological change and innovation (Allen, 2009a); (ii) *Institutions*: Great Britain had institutional advantages in terms of, for example, the rule of law and secure property rights facilitating economic growth (Acemoglu et al., 2005a; Koyama, 2016; North et al., 2009); (iii) *Colonization*: The slave trade generated profits used to finance industrial growth (Heblich et al., 2022; Inikori, 2002; Solow, 1987; Williams, 1964), and the New World provided a market for Great Britain to trade manufacturing goods for primary products (Pomeranz, 2000); *Culture*: Changes in norms and values meant that the pursuit of profits by the bourgeois became the norm and was not any longer socially disapproved of (McCloskey, 2006, 2010, 2016); and (v) *Science and Innovation*: Scientific insights and upper-tail knowledge were increasingly shared and discussed across Europe (Mokyr, 2009, 2016; Squicciarini and Voigtländer, 2015), while Great Britain was well endowed with skilled artisans, craftsmen, and engineers who would invent the technologies underlying the First Industrial Revolution (Kelly et al., 2014, 2022).[7]

Yet, it was the Second Industrial Revolution starting around 1850, that saw the spread of growth to other countries, also setting them on a path toward sustained economic development.[8] During this process, countries such as the USA or Germany caught up and even overtook Great Britain (Allen, 2011a, pp. 8, 40). Consequently, a key question is how such countries overcame their initial *relative backwardness* (Gerschenkron, 1962).

Allen (2011a, pp. 40–60, 78–83) argues that there were three main drivers of economic growth during the Second Industrial Revolution: technology, globalization, and state policy. This is echoed by DeLong (2022, pp. 1–25) arguing that globalization, industrial research labs, and the modern corporation were at the core of the industrialization process. To industrialize, (Western) countries pursued a relatively common strategy that was first developed in the USA and later popularized in Europe. As part of this general model, governments drove the installation of new infrastructures such as railways, which, together with advances in international transport using steamships, drove market integration. Yet, the state also retreated in other aspects, which contributed to economic growth as well. For example, the state took a larger role in creating unified internal markets by

[7]The debate about the causes of the First Industrial Revolution remains prominent. For example, Humphries and Schneider (2020) question the high-wage interpretation of British history by Allen (2009a), and (Kelly et al., 2014) argue that this account relies on the assumption that also unit labor costs were higher in Britain compared to other countries, which is not certain. Moreover, some of the proposed arguments should not be seen as incompatible with each other. For example, Crafts (2011) argues that Allen (2009a) mainly shows why there was a demand for technical innovations, while Mokyr (2009) proposes an argument why there was a corresponding supply of innovation and skills. A related literature also shows that the First Industrial Revolution had a more gradual character than often depicted as rapid growth and technological dynamism were largely restricted to a few industries, including textiles, iron, steel, coal, and transport (Crafts and Harley, 1992; Temin, 1997).

[8]While highlighting differences in the process of industrialization across countries provides for a more concise discussion, such a level of aggregation does not necessarily reflect the actual process with which industrialization occurred. As Pollard (1981) shows, industrialization often enfolded along regional lines.

abolishing internal tariffs (Allen, 2011a, pp. 40–60, 78–83). Internationally, countries began exporting goods using factors of production that were relatively abundantly available so that trade patterns followed the Heckscher-Ohlin model (Persson and Sharp, 2015, pp. 173–177). Finally, the development of a banking system centering around newly established central banks secured the provision of credit to domestic firms and the stabilization of currencies, and mass education helped improve the diffusion of technology and speed of innovation. As such, while the First Industrial Revolution was an essentially unplanned event, later processes of industrialization were based on at least some form of institutional and state interventions (Allen, 2017; Gerschenkron, 1962, 1968). Within this process, a stylized fact maintains that the larger the relative backwardness of a country initially was, the more intervention was needed (Gerschenkron, 1962).

One influential area where the state took a larger initiative to drive economic growth was tariff policy by using external tariffs to protect domestic manufacturing. Yet, the (potential) success of this policy remains debated. The industrializing USA was one country that imposed high import tariffs during the nineteenth century and noticed substantial simultaneous growth in productivity and output. However, an alternative explanation maintains that American growth was driven by high wages prompting the search for labor-saving new technologies (Allen, 2011a; Habakkuk, 1962). While (Western) economies generally moved with the Cobden-Chevalier treaty of 1860 toward free trade in the late nineteenth century and abolished mercantilistic thinking, this was reversed after the 1880s due to the influx of cheap (American) grain. This development first prompted increases in agricultural and later manufacturing tariffs.[9] Bairoch (1972) was the first to establish a positive correlation between economic growth and tariffs, which was later substantiated by O'Rourke (2000) and Lehmann and O'Rourke (2011). However, the robustness of this result has been questioned (Irwin, 2006; Schularick and Solomou, 2011; Tena-Junguito et al., 2012) as it varies across countries (Lampe and Sharp, 2013). As I discuss in more detail below and in Paper III, one reason for this heterogeneity could be that tariffs have a heterogeneous impact across establishments (Shu and Steinwender, 2019), which has not yet been possible to test using historical data, however.

Another key aspect of the Second Industrial Revolution was its focus on scientific advances (Koyama and Rubin, 2022; Mokyr, 1992, 2002, 2009, 2016). While technologies of the First Industrial Revolution were mainly aimed at mechanizing previously known methods, during the Second Industrial Revolution, science drove technological developments, for example, in medicine, chemicals, transport, energy, and food production. Thereby, a basic level of education and literacy became increasingly important to apply new technologies and processes successfully (Becker et al., 2011; Koyama and Rubin, 2022; Mokyr, 2002, 2009; Squicciarini, 2020). This reflects arguments by Abramovitz (1986) pointing out that backward countries that are *socially advanced*—e.g., in terms of their education system, ability to manage large-scale firms, and/or the creation of a functioning market—are more

[9]See Paper III or, for example, Persson and Sharp (2015, pp. 179–182) for more details.

likely to experience catch-up growth. As further argued below, pre-industrial Sweden, by being an "impoverished sophisticate" (Sandberg, 1979, p. 225), was such a case.

Apart from European countries, Imperial Russia and Japan were important industrializers during the nineteenth century. However, in contrast to the general model presented above, they adopted slightly different strategies to industrialize. While Imperial Russia, for example, also relied on tariffs to protect itself from foreign competition and enlarged its market through railway construction, foreign capital was used to finance industrial development. This ran counter to the case of, for example, Germany, which mainly leveraged its close connections between banks and industry to finance industrialization. However, industrialization in Imperial Russia was not widespread, and the economy remained predominantly agrarian until World War I. Japan was Asia's first country to industrialize, albeit under different circumstances than the West. While education reforms played a key role, the country did not possess autonomy over its tariff schedule to protect its internal market. Moreover, as wages were generally low, Western technology that was developed to save on (relatively expensive) labor had to be modified to be profitably applied in Japan (Allen, 2011b, pp. 114–130).

The advent of the Second Industrial Revolution also had far-reaching consequences on the organization of work and its character. During this period, the *factory* became the dominant mode of production across industries, replacing previous non-mechanized and small-scale establishments, that is, artisan shops and cottage industries (Atack, 1987; Sokoloff, 1984). By combining efficiency gains from the division of labor and mechanization using steam or water power, standardized production in factories became the new norm. Essentially, this process reflected Schumpeterian creative destruction applied to the organization of work (Allen, 2017, pp. 42–45, 58–59, 71–83).

Yet, living standards did not immediately improve. Especially in Britain, industrialization was associated with polluted cities, unsafe working conditions, bad hygienic conditions fostering the spread of diseases, and child labor. Overall, it took time until (British) real wages appreciably rose and state action was undertaken to address the Social Question (Allen, 2017, pp. 1–10, 100–102). Newer evidence questions that living standards stagnated, finding that wages increased in Britain's industrial regions (Kelly et al., 2022). With rising wages, consumers upgraded their consumption baskets by purchasing higher-quality goods (Allen, 2017, pp. 31–33). With increasing incomes, people also started to consume relatively more services. Indeed, while much focus has been put on developments in industry, especially the American economy developed large-scale methods in the production of services for mass markets. Consequently, these developments made the USA forge ahead of Britain after 1900 (Broadberry, 2006; Broadberry et al., 2018). Thus, already around 1900, about 30 percent of the American workforce was employed in services (Broadberry et al., 2018).

Against this backdrop, it is important to restate that not all economies around the world industrialized (Figure 1). For example, Allen (2017, pp. 106–110) documents how the Indian textile industry was essentially outcompeted by the British in the early nineteenth century. Overall, such diverging developments led to a *Great Divergence* (Clark, 2008, p.

2), that is, the widening in terms of GDP per capita observed in Figure 1.[10] Consequently, it becomes necessary to understand how some countries industrialized, while others did not. As the next sections demonstrate, this is best done using establishment-level data, and Sweden presents a good case for analysis.

2.2 Swedish Industrial Development

2.2.1 Sweden's Industrialization in a Historical Perspective

As the First Industrial Revolution was generally confined to Great Britain, widespread economic development only occurred with the industrialization of follower countries (Allen, 2011a, pp. 8, 40). One important late-industrializing country is Sweden, which was by 1850 still a relatively poor and agrarian economy located on the European periphery.[11] Sweden's subsequent industrial transformation has often been heralded as highly successful as by 1900, it was among the fastest-growing countries worldwide (Schön, 2012, pp. 82, 136–137). Figure 1 from the introduction reflects these developments showing that Swedish GDP per capita began to exhibit sustained growth only during the nineteenth century. As such, while the gap between Sweden and the leading economies of the time—i.e., the United Kingdom and the United States—widened before the 1850s, it closed toward the end of the nineteenth century.[12] Additionally, in terms of wages, Sweden converged with the leading economies during this time (Prado, 2010; Williamson, 1995). Newer GDP data slightly qualify the view that Sweden experienced a rapid industrial breakthrough, however. Edvinsson (2013) reestimates Swedish GDP, especially improving the treatment of agricultural and home production. This new series shows that Sweden was initially richer and subsequently grew more slowly than previously thought. As such, Sweden was not as backward relative to other countries in the early nineteenth century as previously argued, which is consistent with arguments by Hamark and Prado (2022).

While economic historians generally agree that there was an industrial revolution in Sweden during the late nineteenth century, they disagree regarding the dating of its beginning, and Gustafsson (1996) summarizes this debate. Eli Heckscher, the doyen of Swedish economic history, sees the 1870s as the beginning of Swedish industrialization as by then, the *ancien régime* was replaced by an economy organized around liberal principles and based on modern technologies.[13] Accordingly, the previous period between 1815 and 1870 laid the foundation for the country's economic breakthrough (Heckscher, 1938, 1941). In

[10] A related literature analyzes the *Little Divergence*, which is the process by which Northern Europe pulled ahead of Southern Europe in terms of economic growth already before 1750 (e.g., de Pleijt and van Zanden, 2016).

[11] If not otherwise specified, the figures displayed in this section use the main data set as defined in Paper I of this thesis. The observation in this section that my data, when aggregated, closely follow the overall Swedish economic development further increases their reliability. For more details about the data, see Section 3.

[12] Also, in comparison to Germany, Sweden was less-developed economically before 1900 as Figure 1 highlights

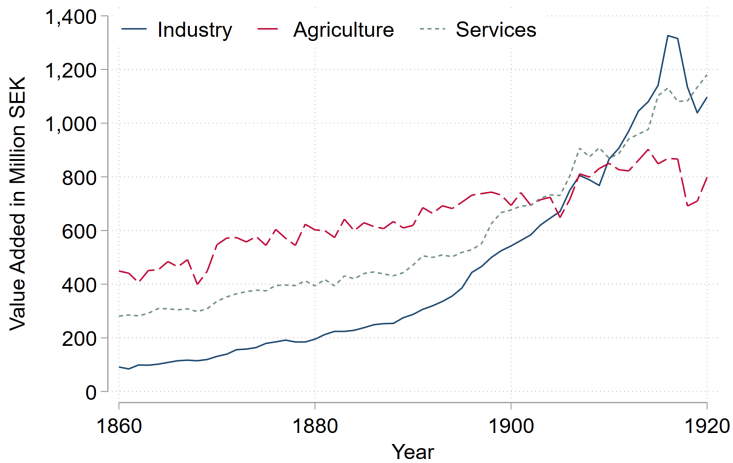
[13] See also Section 2.2.2 regarding these developments.

contrast, Arthur Montgomery argues that already the 1860s exemplified the dividing line as agriculture subsequently lost its primary role, the sawmill industry rapidly grew, available surplus labor decreased, and factory production spread across multiple industries (Montgomery, 1939, pp. 40–41). Torsten Gårdlund agrees with Heckscher's dating, emphasizing the diffusion of new technologies and mechanization, the importance of Sweden's skilled and educated engineers for economic growth, improvements in communications and banking/credit provision, and increased market size (Gårdlund, 1942, p. 60). Lennart Jörberg also focuses on the 1870s, pointing to the investments in railways and high economic growth rates. Yet, he also highlights that growth was rapid already in the 1850s and before (as well as later in the 1890s), which was centered around iron and textile production (Jörberg, 1965). Lennart Schön puts especially the growth of textiles at the heart of Sweden's industrialization, which occurred already before the 1850s (Schön, 1979, pp. 75–83). Overall, the relative dating of Sweden's industrial breakthrough is not of utmost importance to this study. As such, it suffices to note that this thesis covers the decades—i.e., the period between 1860 and 1900—that are generally thought crucial for Swedish industrialization by all these authors. Ultimately, industrialization is a process, and the growth dynamics change over time, as outlined in the previous discussion. This dynamism is reflected in the thesis in, for example, Paper I showing how factory production developed an advantage over other forms of production only over time.

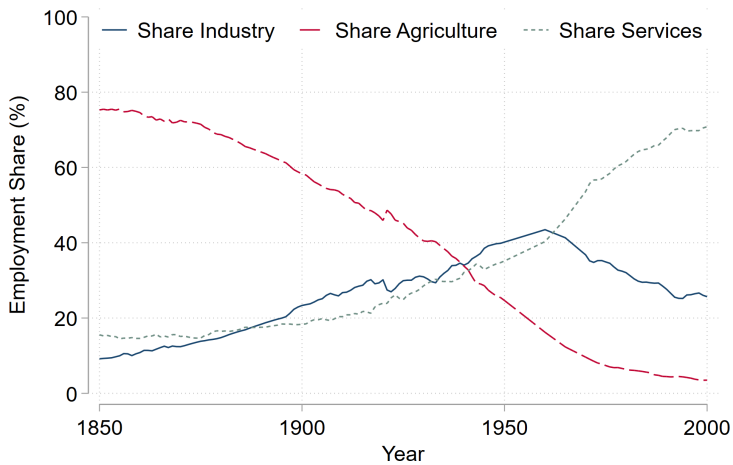
Figure 5 shows how industry, services, and agriculture expanded in Sweden throughout the late nineteenth century. Yet, in a relative sense, employment shifted from agriculture to industry and services. The origins of Sweden's industrialization have often been traced to a transformation of agriculture in the early nineteenth century allowing for a substantial expansion in food production, population growth, and the switch to industry as the main sector of the economy (Schön, 2012, pp. 39–41, 82). During this process, new technologies, including, for example, moldboard plows and harrows, were being applied to a larger extent. Improvements in the drainage systems, as well as the more extensive usage of horses and draught animals, enabled a more intensive use of land (Gadd, 1983; Magnusson, 1983, 2010). Additionally, the introduction of new crops such as the potato increased the calories available to the population (Gadd, 1983; Herlitz, 1988; Isacson, 1979). Indeed, causal estimates suggest that the introduction of the potato accounted for about 10 percent of the population growth between 1800 and 1850 (Berger, 2019a). Institutional change was another important driver of the agricultural transformation. The enclosure movement, as well as the development of markets and determination of property rights, increased the incentives of peasants to increase investments, which then raised farm-level output and productivity (Olsson and Svensson, 2010).

The development of industry alongside agriculture has also been referred to as a period of proto-industrialization.[14] An influential account maintains that this created the precon-

[14]Ogilvie (1993) discusses different accounts regarding the role of proto-industrialization in driving economic development.



(a) Value added



(b) Sectoral employment shares

Figure 5: The Swedish industrial breakthrough
Source: Schön and Krantz (2015).
Notes: The value added is stated in million SEK in constant 1910/1912 prices. Industry refers to manufacturing. Services comprise private and public services. The sectoral shares are based on employment and are calculated relative to the sum of the three sectors.

ditions for industrialization along two dimensions. First, a growing number of landless laborers provided the supply of workers necessary for industrial development. Second, the agricultural transformation created the demand for more and better machinery. In response, different cottage industries developed to meet this demand (Schön, 1982, 2012).

Factory production first developed in textiles before spreading to other industries. The demand for textiles was initially driven by the upper classes, subsequently by the well-off farmers, and after 1850 by the lower classes seeing increases in their incomes. During this period, textile production also shifted toward lower-quality goods, which were more affordable for the general population. The rapid mechanization of especially cotton weaving increased productivity, whereas older handicrafts, such as woolen factories, retreated. Notably, this initial emergence of factory production occurred during a period of generally declining demand as the export sector did not yet exert an impetus to growth (Schön, 1979, pp. 178–183).

Sweden's industrialization became more firmly rooted after the 1850s. Figure 6 highlights this process, using as a stylized fact the diffusion of the steam engine that replaced older power sources, such as water or animal power. A central pillar of Swedish economic growth was the export of staple products, including iron, timber, and oats, for which international demand—especially starting with the Crimean War in 1853—was high. One leading industry was centered around the sawmills in Northern Sweden, which were key to the export of sawn timber to notably Great Britain. A key resource constraint for Swedish economic development was that the country had no coal deposits to fuel steam engines. In contrast, sawmills could naturally use waste wood to operate the new power sources (Schön, 2012, p. 54, 63, 103). However, such relationships should not be overstated, as the availability of coal was of key importance primarily during early industrialization. With declining transport costs during the Second Industrial Revolution, coal became more widely available (Clark and Jacks, 2007; Kander et al., 2013; Pollard, 1981; Pomeranz, 2000). In the long run, technological advances also helped in reducing the energy intensity of the Swedish economy (Kander, 2002), and new processes to, for example, produce steel were adapted to the Swedish conditions (Schön, 2012, pp. 57, 105–108).[15] As such, it is not surprising that, as Paper II highlights, the steam engine was applied across all industries. Furthermore, new production methods were also used in steel manufacturing, so Sweden caught up to the internationally leading countries (Prado and Molinder, 2022; Schön, 2012).

Notably, the Swedish industrial breakthrough was not only confined to the export sector. Next to textiles, as sketched above, also, for example, the food industry was booming and among the first industries to install steam power. Other industries grew in response to domestic demand as well. Mechanical workshops producing, for example, rolling equipment, arms, ships, and domestic consumer goods, experienced rapid growth. In later decades, a chemical industry also developed centering around matches, candles, and soap. Economic developments in the 1870s were less expansive as the first financial crisis with industrial roots occurred in 1878. The subsequent slowdown in economic growth has often

[15]Kander et al. (2013) place the availability of energy at the heart of economic growth. They show how coal—and later electricity and oil—relaxed the energy constraints faced by economies.As such, it was first the steam engine that could use coal to solve another constraint of pre-industrial economies, that is, the provision of sufficient power. Cheap coal also made possible advances in the production of iron and steel. These effects reinforced each other, ultimately driving industrialization.

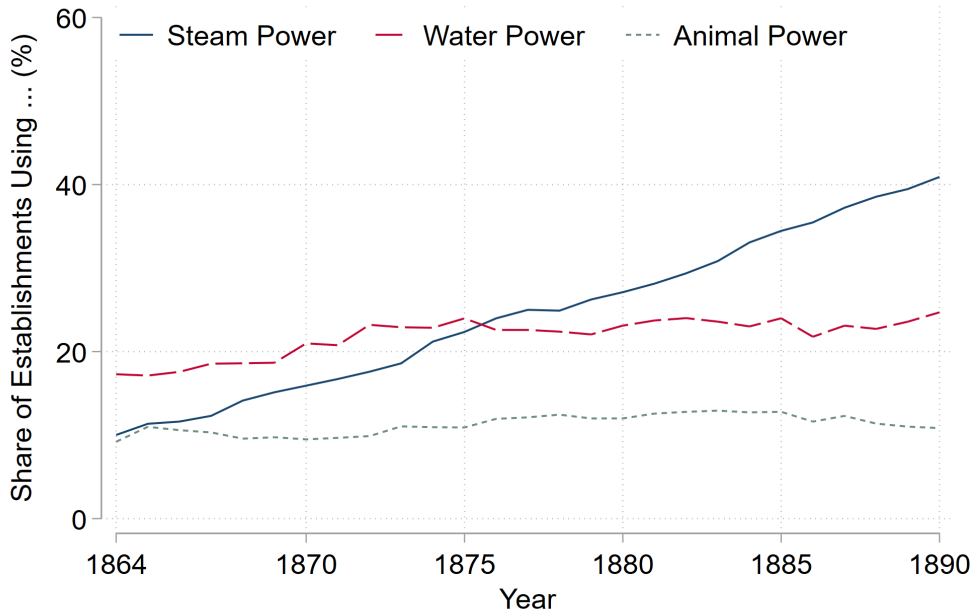


Figure 6: Establishment-level technology use
Source: Fabriksberättelserna.
Notes: The figure displays the share of establishments using steam, water, or animal power in a given year.

been seen as an economic depression. Yet, this overshadows the fact that growth continued and new activities in, for example, chemicals or food production emerged, which played an important role in the next decades (Jörberg, 1961; Schön, 2012).[16]

As a way of summarizing the general patterns of Swedish industrial development, Jörberg (1961, pp. 42–43, 122–135) distinguishes between capital—e.g., wood, iron, and chemicals—and consumer goods—e.g., food, textiles, printing—industries. According to this analysis, consumer goods industries produced mainly for the domestic market and were dominated by establishments of a rather small size. In contrast, the capital goods industries produced for the export market and were dominated by relatively larger establishments. Prado (2014) uses the analogy of *yeast*- and *mushroom*-like growth processes to evaluate whether Swedish growth proceeded evenly (yeast) or unevenly (mushroom) across industries. This investigation reveals that Swedish growth resembled a mushroom-like process, so some industries experienced fast growth rates, whereas others lagged. Especially textiles, dairy, metal, chemicals, paper, and timber industries noticed the fastest growth rates, whereas raw materials saw lower growth rates.

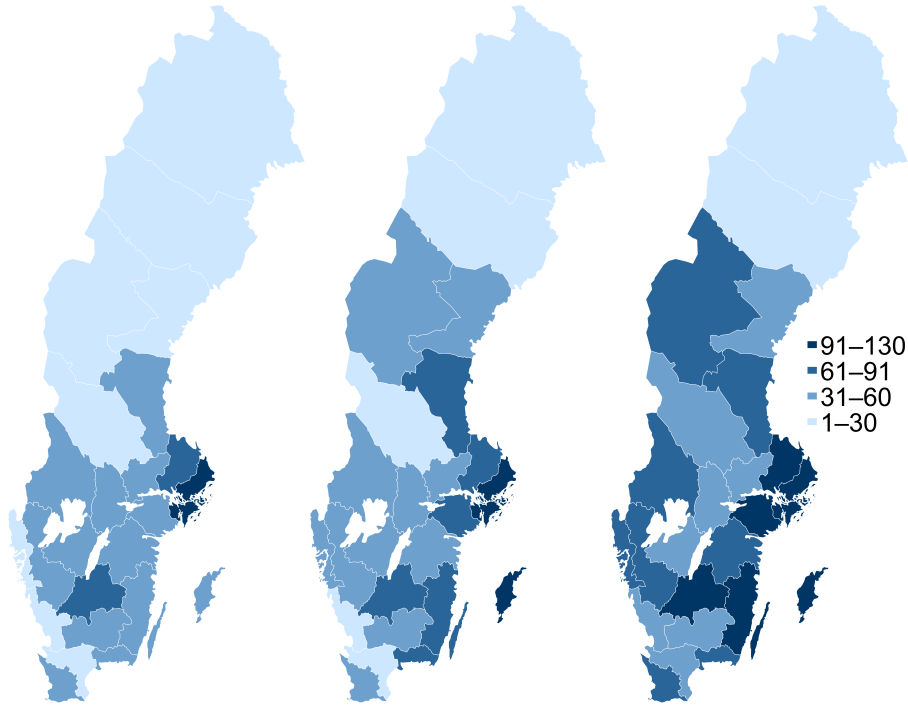
[16]Jörberg (1961, pp. 334–363) examines cyclical fluctuations in Swedish growth in detail concluding that the Swedish economy was generally resistant to cyclical downswings originating from international trends.

Subsequent studies focus on the regional patterns underlying Swedish industrialization. One influential hypothesis states that regional disparities tend to increase during early industrialization, whereas they decline during later stages as the economy develops (Williamson, 1965). Indeed, there is evidence that regional divergence occurred during the early phases of Swedish industrialization (Berger, 2016, p. 26). Yet, in the long run, regional convergence occurred in Sweden, which was relatively more notable than in other (European) countries. In the late nineteenth century, this regional convergence was mainly driven by internal—especially the forestry sector in Northern Sweden attracted workers—and external—many Swedes migrated to the USA—migration. Within agriculture, many people also switched to jobs with higher productivity (Enflo et al., 2014b; Enflo and Missiaia, 2020; Enflo and Rosés, 2015).

As further documented in Paper I, Swedish industrialization also had a distinctly rural character compared to countries such as the USA, Germany, or Great Britain (Berger et al., 2012; Söderberg, 1984). During the early phases of industrialization, peripheral regions grew as they were abundantly endowed with natural resources—e.g., water power—that capital-intensive industries could rely on to mechanize production (Enflo et al., 2014a). Similarly, the installation of railways contributed to the industrialization of peripheral areas (Berger, 2019b). Major urbanization occurred only in later stages during Swedish industrialization and especially after the economic breakthrough of the 1890s (Schön, 2012, pp., 82, 90, 96, 135–135).

The data employed in this thesis generally mirror such economic developments. Figure 7 displays the number of industrial establishments per 100.000 inhabitants within Sweden's 24 historical counties (*län*) across the second half of the nineteenth century. While some regions—most notably Stockholm—stood out with a high density of industrial establishments early in the analysis period, the number of industrial establishments per 100.000 inhabitants grew across regions in the subsequent decades reflecting regional convergence. Moreover, the share of establishments located in rural areas was substantial already early in the period of analysis and did not appreciably decline later (Appendix Figure A.3).

While the period of my analysis ends in 1900, the following decades represented Sweden's definite industrial breakthrough. Older sectors centered around the export of, for example, iron, timber, and oats lost in importance, so production and demand shifted to newer industries centered around engineering, motor engines, power, paper, pulp, graphics, and consumer goods industries. These new firms were highly innovative and partly based on the older mechanical workshops. Many establishments founded during the previous decades brought their innovations to economic success in the 1890s. As such, Sweden was forging ahead instead of merely catching up. Among the most prominent engineering companies were, for example, AGA, ASEA, LM Ericsson, Separator, and SKF, which were linked to famous innovators like Dalén, Wenström, Ericsson, de Laval, and Wingquist (Schön, 2012, pp. 52, 58–62, 103–111, 132–137).



(a) 1870 (b) 1880 (c) 1890

Figure 7: Number of industrial establishments per 100.000 inhabitants by region
Source: Fabriksberättelserna and Enflo et al. (2014a).
Notes: The figure shows the number of establishments per region per 100.000 inhabitants. The number of inhabitants per region and year is taken from Enflo et al. (2014a).

2.2.2 Swedish Policy During Industrialization

As discussed above, state policy played a relatively larger role during the Second Industrial Revolution. In Sweden, the state also undertook larger initiatives in driving economic development while also stepping back by allowing market forces to operate. As such, between 1848 and 1864, different reforms were passed, essentially creating a free and unrestricted market in Sweden. This deregulation first abolished the guild system, while later, every legal person of age was allowed to start their own business. The introduction of mandatory schooling increased the general literacy and proficiency of the population, reflecting that the Second Industrial Revolution was based to a larger extent on knowledge-intensive industries, as also discussed in the previous section. As such, Sweden has often been described as an *impoverished sophisticate* where the stock of human capital needed to sustain industrialization was already high before growth started (Sandberg, 1979). The labor market was also liberalized as restrictions to moving within Sweden were abolished. Similarly, there

were no restrictions on international capital movements, which were further facilitated in 1873 when Sweden joined the gold standard. While Sweden's central bank Riksbank decreased the issuing of banknotes following the joining of the gold standard, growth was financed through commercial banks and domestic and international investments (Gårdlund, 1947; Schön, 2012). As such, the banking system grew and became more formalized—e.g., limited and unlimited liability banks traditionally operated in Sweden, which were now governed by similar legislation implying that unlimited liability banks lost their rights to issue their own notes—as well as involved in financing industrial development (Broberg, 2006; Gårdlund, 1947; Grodecka-Messi et al., 2021; Ögren, 2019). Overall, labor, capital, and commodity markets were unrestricted in late nineteenth-century Sweden (Gårdlund, 1947; Schön, 2012). Another important legislative change was the introduction of general incorporation laws, whereby incorporation in Sweden essentially became a matter of registration (Schön, 2012, pp. 91–94). This contrasted other late-industrializing countries such as, for example, Imperial Russia, where the incorporation process remained restrictive (Gregg, 2020) arguably delaying industrialization (Gregg and Nafziger, 2019, 2020).

A key question in economic history is to which extent such changes drove industrialization. Regarding the role of the corporation, for example, it is generally argued that the possibility to incorporate improves access to capital and reduces the risks of individual investors in making joint investments so that establishments can overcome the capital constraints they face (Gregg, 2020; Robinson, 1952). Davis (1905, p. 1) succinctly summarizes this when stating that "[the] most important and conspicuous feature of the development of society in Europe and America on its formal or institutional side during the past century (and particularly during the second half of it) [i.e., the nineteenth century] has been the growth of corporations."

However, the role of the corporation in economic development is not universally accepted as (i) scholars have suggested that the formal banking system could provide the necessary credit (Rousseau and Sylla, 2005; Rousseau and Wachtel, 1998) and (ii) general incorporation laws arguably came too late to be the fundamental cause of long-run growth Rosenberg and Birdzell Jr. (1986, pp. 189–191, 269–271). In some instances, the corporate form may have even hurt economic development due to oversight problems (Hilt, 2006). Relatedly, Guinnane et al. (2007) argue that not the corporation but the private limited liability company was key as this form of business combined the advantages of the corporation with the flexibility needed by small businesses. While across countries, there is evidence that economies using the corporate form to a larger extent grew faster (Foreman-Peck and Hannah, 2015), aggregate data preclude us from making any definite conclusion as to whether the ability to incorporate contributed to economic growth or whether it was its consequence. This is best summarized by Jörberg (1961, p. 211), who writes that "[w]e can only state that industrialisation and incorporation were contemporaneous, but to what extent they affected one another; nothing can be stated with any certainty."

In contrast, establishment-level data enable us to disentangle this chain of causality and analyze the corporation's role in economic development. For example, Gregg (2020)

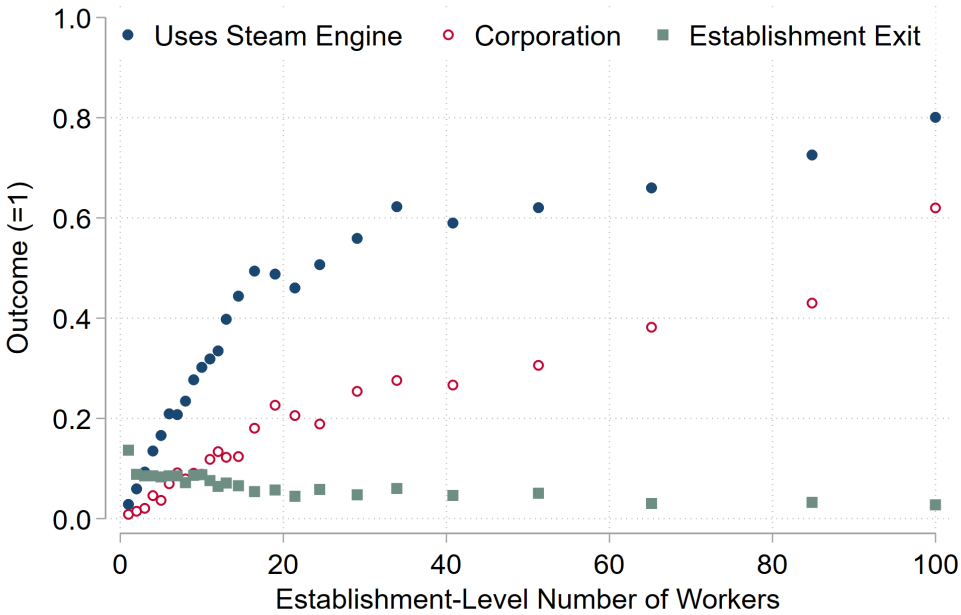


Figure 8: Establishment-level organizational choice and performance
Source: Fabriksberättelserna.
Notes: The figure displays binned scatter plots of selected measures of establishment-level performance on establishment-level size measured as the number of workers. For ease of viewing, all establishments with more than 100 workers are assumed to have 100 workers.

shows that in Imperial Russia, relatively more productive establishments incorporated and adopted machinery, which then further increased productivity. In Sweden, there seemingly exists a connection between establishment-level size, technology choice, and performance as well. As Figure 8 shows, larger establishments were more likely to be incorporated and use steam power as well as less likely to exit. In particular, this relationship seems to hold among smaller—e.g., 20 workers and less—establishments (see also Broberg, 2006, pp. 284–285). As such, it can be hypothesized that general incorporation helped a broader set of establishments to grow. Consequently, Paper II analyzes this question in more depth.

The Swedish state also took a larger role in designing infrastructure projects to integrate the country and contribute to urban development. The arguably most important infrastructure project in the second half of the nineteenth century was the building of railways. Railways represented a key development block as they integrated internal markets and spawned growth in related sectors such as, for example, the steel or engineering industries (Schön, 2012, p. 92). Railways also had positive effects on local economic development. Gaining access to the railroad increased local economic growth and led to a reallocation of economic activity from non-connected to connected areas. This set regions

on a differential growth path persisting until today (Berger, 2019b; Berger and Enflo, 2017). Similar infrastructure projects related to the building of water and sewerage systems. This had positive health effects as waterborne, infant, and all-cause mortality declined (Helgertz and Önnerfors, 2019).

Swedish trade policy followed the international developments discussed above to promote industrial development. With the general liberalization of its economy, Sweden joined 1865 the international trade network resulting from the Cobden-Chevalier treaty. As such, import duties were massively reduced, which reflected the general trend across countries until the 1880s (Lampe, 2009; Schön, 2012). Under the influx of cheap (American) grain, many countries reinstalled import tariffs during the late nineteenth century, first on agricultural and later manufacturing products. Sweden was no exception in this regard (Bohlin, 2005; Persson and Sharp, 2015). As discussed above, it is empirically unclear whether this reintroduction of tariffs drove industrial growth. In Sweden, while higher tariffs arguably promoted the development of industries producing domestic consumer goods (e.g., Bohlin, 2005; Hammarström, 1970; Schön, 1989), such effects were likely small. While tariffs led to a decline in import competition, they did not increase labor productivity within industries or shift labor from agriculture to industry (Persarvet, 2019). Yet, as the impact of tariffs generally differs across establishments (Shu and Steinwender, 2019), looking at the average economic impact of tariffs is not effective in assessing whether infant industry protection worked. Again, establishment-level data are necessary for this purpose, and Paper III provides such an analysis.

2.2.3 Two Perspectives on Swedish Industrial Growth

Two models have traditionally been proposed to explain the Swedish industrial breakthrough as sketched above. The *Export Model* is mainly associated with Lennart Jörberg Jörberg (1961, 1973). It stresses the importance of external factors for Swedish growth.[17] This view maintains that initially, the domestic market was too small to drive industrial growth. Instead, foreign demand for Swedish staple goods transformed the economy toward having a broader industrial base. The three leading Swedish export products of the time were iron, oats, and timber, which were abundantly available in the country, as sketched above. Given an ample supply of labor and consequently relatively low wages, the international demand from countries such as Britain could be flexibly met. The profits gained from the exports were consequently reinvested and spent so that also industries producing for the domestic market grew. Similarly, O'Rourke and Williamson (1995a) and O'Rourke and Williamson (1995b) stress that Heckscher-Ohlin forces—i.e., integration in terms of global factor and commodity markets—largely account for Swedish growth. Especially Swedish emigration

[17]Heckscher (1954, p. 209–214) generally echoes the conclusion that foreign trade was crucial for Swedish growth. However, he notes that "Sweden did not *cease* being on the receiving end until around 1910" (Heckscher, 1954, p. 209).

to the USA also helps explain why wages remained high in Sweden in the later decades of the nineteenth century.[18]

Yet, the observation that other countries following an export-led strategy have not industrialized questions the explanatory power of the export model (e.g., Álvarez and Prado, 2022). In contrast to primarily focusing on exports, the *Domestic Market Model*—traditionally associated with Lennart Schön and Jonas Ljungberg—focuses on the role of capital imports and domestic market integration to explain Swedish economic growth. This model emphasizes how an agricultural transformation at the beginning of the nineteenth century drove market integration and institutional change within Sweden already before the export industries started growing. As the domestic market successfully competed with export industries, wages remained high, spurring technological change and driving unprofitable businesses out. Additionally, capital imports were extensively used to finance industrialization, which also enabled an increase in domestic consumption (Andersson and Prawitz, 2022; Ljungberg, 1996; Ljungberg and Schön, 2013; Prado and Molinder, 2022; Schön, 1997).

Overall, the two models should not be seen as contradictory as both internal and external factors are seen as contributors to Sweden's industrialization today (Prado and Molinder, 2022). As such, the goal of this thesis is not to prove or disprove one of the models. However, since the export model is the arguably more traditional explanation for Swedish industrialization, it is noteworthy that my results underscore the importance of internal factors for Swedish and general economic growth. For example, I show that the factory system also developed within industries producing relatively more for domestic consumption, and my novel data enable me to study the underlying drivers of this process. Similarly, Paper IV shows how industrial growth created further domestic growth dynamics within the local service sector. As such, my findings resonate with this literature, emphasizing that domestic markets alone can create growth dynamics.

2.3 Industrialization through an Establishment-Level Perspective

The previous two sections summarize existing accounts for why countries—and especially Sweden—industrialized while also highlighting that several questions underlying this process cannot be (fully) understood using aggregate data. This section shows how a growing literature leverages establishment-level data, enabling a better understanding of how some countries industrialized and others not.

In historical research, the availability—and consequently the use—of establishment-level data has generally been restricted. Pioneering work in collecting historical establishment-level data was undertaken in the USA. These efforts resulted in the digitization of different samples from the American Census of Manufactures, covering selected years of the nineteenth century. Atack and Bateman (1999) provide a systematic review of this data. However, due to technical limitations, these data only contain a sample of

[18]Bohlin (2007) also bolsters the case that the export model explains Swedish industrialization.

American manufacturing establishments, give no information regarding the names of establishments, and are only available on a decennial basis (Atack and Bateman, 1999).[19] As such, linking establishments over time to account for time-invariant confounding variables is not possible (e.g., Atack et al., 2008). While the American manufacturing data include information on slightly more variables (Atack and Bateman, 1999), my Swedish establishment-level data are unique as they are annually available so that all establishments in selected industries can be linked across time. Such a setting allows me to, for example, study survival directly at the establishment level, whereas previous scholars had to rely on more indirect evidence (Atack, 1985). A further difference is that the American manufacturing census was carried out in conjunction with the population census, whereas the Swedish manufacturing census had the collection of collecting establishment-level data as its only objective. Section 3 expands on these points.

The traditional view of (American) industrialization puts the rise of the factory at its center, that is, an establishment that relies on mechanized production through inanimate power sources. A large literature in business history traces how such factories emerged to take advantage of expanding markets, eventually displacing non-mechanized producers such as artisan shops (Chandler Jr., 1977, 1990). Yet, using establishment-level data, it is possible to show that contrary to this received view, relatively larger yet non-mechanized establishments remained competitive. Consequently, studies generally interpreted this as evidence that establishments during the early phases of American industrialization realized economies of scale due to the division of labor alone (Atack, 1985, 1986, 1987; Laurie and Schmitz, 1981; Sokoloff, 1984). This (somewhat controversial) finding has later been scrutinized and questioned due to issues with the underlying data (Margo, 2015). However, it is substantiated in more recent studies using other data and more advanced methods (Atack et al., 2016).

Another key insight from this literature is that while the factory became the dominant form of industrial production, a sole focus on factories clouds the variety of organizational forms that establishments used during industrialization. Specifically, this literature highlights the (surprising) persistence of small establishments throughout industrialization, which has been explained by low levels of competition, especially in the countryside (Atack, 1985, 1986, 1987; James, 1983; Sokoloff, 1984; Ziebarth, 2013). As establishments faced heterogeneous access costs, for example, to railway transport, some establishments were naturally shielded from competition. An alternative explanation highlights that small establishments survived by acting as suppliers to factories. However, this has largely been ruled out (Atack, 1985, 1986, 1987; James, 1983; Sokoloff, 1984). While such explanations stress the supply side, the observed dynamics can also be reconciled with a demand-side perspective. Syverson (2004b) and Syverson (2004a) show how thicker markets enable consumers to switch between producers, which ultimately drives inefficient producers out.

[19]Related work by, for example, Laurie and Schmitz (1981) analyzes data from the American Census of Manufactures for individual cities such as Philadelphia. Pioneering work for the textile industry was also undertaken by Clark (1987) and Allen (2009b).

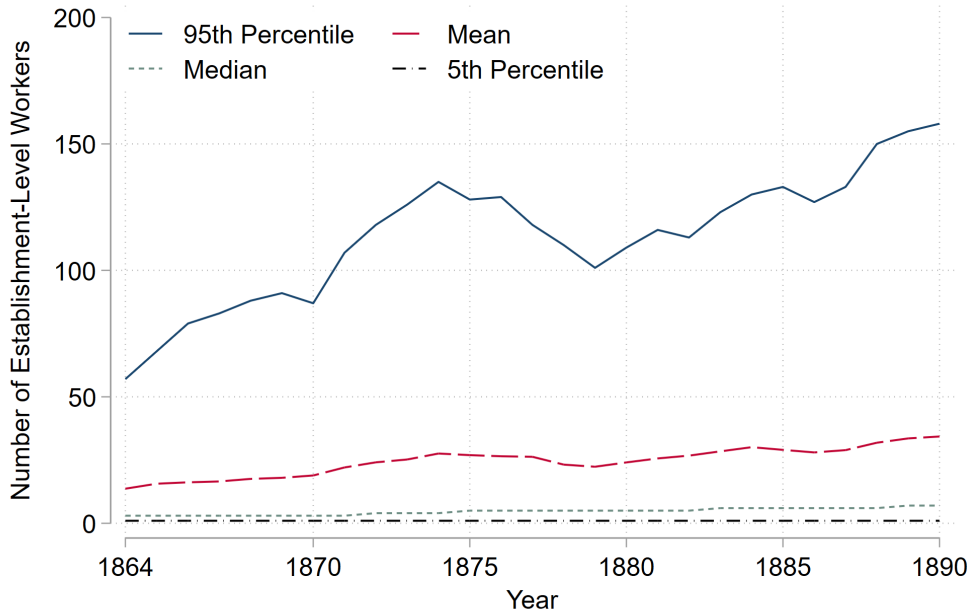


Figure 9: The evolution of establishment-level size
Source: Fabriksberättelserna.
Notes: The figure displays the evolution of establishment-level size using the number of workers as a proxy. For example, the figure shows how many workers the median establishment employed in a given year.

Relatedly, the slow diffusion of new technologies and the factory system more broadly has also been explained by the need to learn how to optimally organize production in factories (Juhász et al., 2021).

For Sweden, my data also highlight that while some establishments increased in size, most establishments remained noticeably small throughout the nineteenth century. As such, the dispersion in establishment-level size widened (Figure 9). Such patterns also broadly hold across industries. A stylized observation is that in capital-intensive industries—e.g., wood, paper, and machinery—establishments were relatively larger. This contrasts less capital-intensive industries—e.g., leather, hides, and hair—in which establishments remained small (Appendix A.5). Overall, such patterns are consistent with the general observation that the advent of the factory system did not necessarily replace artisan production as rising incomes during industrialization boosted the general demand for manufacturing products (Schön, 2012, pp. 113–114). Thus, a key question in this context is how (some) establishments started growing. As discussed next, different strands of research tackle this question.

A larger group of studies—also including establishment-level data for countries other than the USA—analyze the life cycle dynamics of establishments. The first strand within

this literature focuses on part-year operation, which is an understudied phenomenon that occurred in many industrializing countries. This literature finds that establishments that operated more continuously were larger and had a higher capital intensity. However, wages in establishments operating only parts of the year were higher as these establishments needed to compensate their workers for temporary losses of work Atack et al. (2002). Similarly, Gregg and Matiashvili (2022) find that Imperial Russian establishments that operated more continuously had higher rates of mechanization, employed relatively more women and children, were more likely to be located in cities and survive and had higher productivity. Relatedly, Atack et al. (2003) show how a decrease in the number of daily hours worked together with an increase in the annual days of operation increased the productive efficiency of establishments.

The second strand in this literature focuses on the entry, exit, and survival patterns of establishments. This literature analyzes how external factors such as the business cycle affect establishment-level survival (Artunç, 2017) and how establishment-level characteristics shape the likelihood of exit. Specifically, Gregg and Nafziger (2019) and Gregg and Nafziger (2020) show that in Imperial Russia, entering corporations were observationally weaker than corporations that existed previously as partnerships. However, new corporations quickly caught up with incumbent establishments, resulting in a lower likelihood of exit. Relatedly, it has been argued that with increasing mechanization, establishments could, to a greater extent, rely on female and child labor. The associated cost reductions then increased the likelihood of establishment-level survival (Eriksson and Stanfors, 2015; Goldin and Sokoloff, 1982, 1984).

While establishments leveraged some efficiency gains from the division of labor (Sokoloff, 1984), the application of inanimate power sources to mechanize production has often been highlighted as key for establishments to grow larger (Atack et al., 2008; Jones, 1987, 1999; Landes, 1969, 1986; Okazaki, 2021). Consequently, a large group of studies looks at both the determinants and consequences of technology diffusion. Atack et al. (2008) shows that—as theoretically expected—the benefits of using steam power were increasing in establishment-level size. As such, larger establishments were more likely to adopt steam power and had higher productivity. Okazaki (2021) and Atack et al. (2022) echo that mechanization increased establishment-level productivity. Yet, other factors, such as the division of labor and high-volume production, were also important for productivity gains realized when mechanizing production.

Related studies analyze the effects of technological change in driving the urbanization of manufacturing production and on the workforce. While Rosenberg and Trajtenberg (2004) argue that the diffusion of the steam engine positively contributed to urbanization, this finding is disputed. Kim (2005) and Kim (2006) show that this shift was rather driven by the advent of the factory system. Atack et al. (2021) show that the diffusion of the railroad also contributed to the urbanization of manufacturing. Concerning the effects of mechanization on the workforce, a widespread view maintains that the steam engine (and the rise of the factory) led to a deskilling of workers (Atack et al., 2004; Goldin and Katz,

1996, 1998). However, this has recently been questioned (Atack et al., 2004; Heikkuri et al., 2022; Ridolfi et al., 2022).

As discussed above, establishing that the modern corporation was crucial for industrialization remains challenging. Yet, a growing literature uses establishment-level data to substantiate such channels. Relying on Imperial Russian establishment-level data, Gregg (2020) shows that corporations were larger, more productive, and more mechanized. Given that the country had a restrictive incorporation system at the time, establishments selected into the corporate form based on their previous productivity. After incorporation, however, establishments further increased their productivity by installing machine power. Overall, the corporate form was a useful vehicle for establishments to obtain long-term financing, which was otherwise scarce. In contrast, institutional frictions in obtaining corporate charters delayed Imperial Russian industrialization (Gregg and Nafziger, 2019, 2020). Subsequent studies analyze the different strategies used by Imperial Russian corporations to obtain financing (Dayton et al., 2021). Relatedly, Artunç (2019) analyzes how in Egypt, legal and religious institutions interacted to retard economic development and entrepreneurship, and Artunç (2021) analyzes how different legal systems can impact the governance of establishments and ultimately their survival.

3 Data and Methodology

The main data source used in this thesis is the *Historical Manufacturing Census of Sweden* (in Swedish *Fabriksberättelserna*), which gives detailed insights into the yearly performance of Swedish manufacturing establishments. Since this census was first undertaken in the eighteenth century, it ranks among the oldest industrial statistics worldwide. In a joint effort, researchers at the Institute for International Economic Studies (IIES) at Stockholm University and the Department of Economic History at Lund University—where the author of this thesis is based—have digitized this data for the period 1863 to 1900, which corresponds to the formative years of Swedish industrialization (Schön, 2012, pp. 73–126). This section first introduces the data before assessing their quality. More details regarding the data set and its construction can be found in Almås et al. (2022). The data can also be accessed online at *https://www.historicalmanufacturingcensus.se*.

As a project member, I have been involved in the whole process of creating this data set. Broadly speaking, this involved digitizing the underlying raw material, organizing the data into a consistent format, cleaning the data, and implementing quality checks to ensure its accuracy. While I have contributed to all these steps, my main responsibility in the creation of the data set was to link the individual establishment-level observations into a yearly panel. This section discusses the strategy used to create these links and critically assesses the quality of the data. Section 3.5 briefly presents other data used in the thesis,

which are discussed in more detail in the respective papers.[20] Finally, Section 3.6 gives a brief overview of the empirical methods used in this thesis.

3.1 The Historical Manufacturing Census of Sweden—An Introduction

Sweden sets itself apart by having Fabriksberättelserna, which are among the oldest industrial statistics worldwide that date back to 1739 (Key-Åberg, 1898).[21] From this period, local statistical offices were mandated to survey industrial establishments in their jurisdiction. These surveys were summarized by the local statistical offices and sent to the national statistical office *Kommerskollegium* in Stockholm. In turn, Kommerskollegium aggregated the information, which was then published as Sweden's national industrial statistics. From 1858 to 1910, the aggregated statistics are published in the series *BiSOS D*, which can be accessed through SCB (2019a). In 1911, the series *SOS* replaced these statistics (SCB, 2019b).

Figure 10 shows examples of the forms underlying my data. Among others, the establishments were tasked to report their location, sales value, profits, taxes, technology use, and the number of employees. The employment information is further broken down by age, gender, and whether the employees were living at the establishment or not (in Swedish *mantalsskrivna*).[22] Additionally, as the data record the name(s) of the owner(s) and establishments, it is possible to, for example, determine whether establishments were incorporated or not.[23] To improve the identification of corporations, we additionally linked the establishment-level data to the Swedish registers of incorporated establishments from 1875 and 1882 (van der Hagen and Cederschiöld, 1875, 1882). Finally, Fabriksberättelserna also report the gender of the owner(s) and/or whether establishments were collectively owned.

While other historical manufacturing censuses, such as the American one, cover even more variables, the Swedish historical manufacturing census is unique as it was conducted on a yearly basis. In contrast, the American manufacturing census was collected every ten years (Atack and Bateman, 1999).[24] Consequently, economic historians have recognized the value of the Swedish manufacturing census early on. However, given technical limitations, a comprehensive analysis of the original returns has not been possible. This is best summarized by Eli Heckscher, stating that "[t]o count through the whole material would be possible; but for the entire country and for such a long period of time [...] it would require a small statistical government department" (Heckscher, 1937, p. 158, own translation).

[20]This introduction and the individual papers use Fabriksberättelserna in a version from October 7th, 2022.

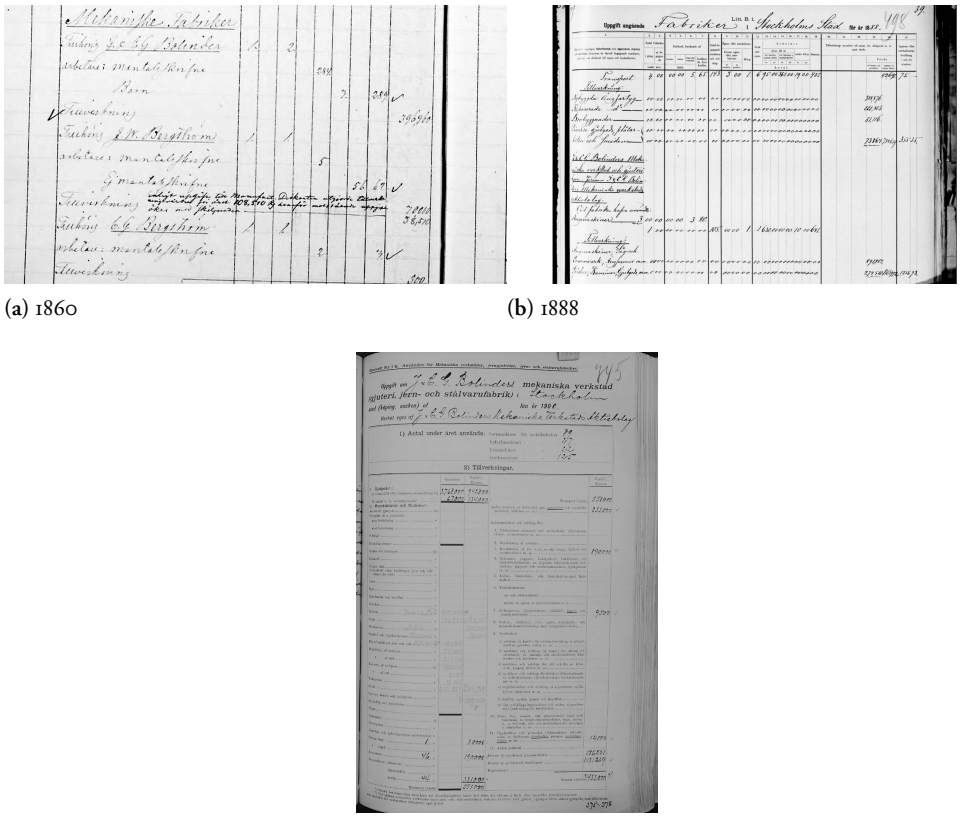
[21]Unless otherwise stated, I use Key-Åberg (1898) as my main reference to introduce and critically assess Fabriksberättelserna. Jörberg (1961, pp. 367–382) provides a similar discussion.

[22]See also the discussion below assessing the accuracy of these variables. Before 1896, the data report the taxes paid by the establishments. As these are 1 percent of profits (Kommerskollegium, 1919), it is possible to calculate a consistent series of profits and taxes over time.

[23]This is done by searching for terms such as *Aktiebolag* or *A.B.*, which in Swedish denote corporations.

[24]Atack and Bateman (1999) introduces and critically assesses the American manufacturing data.

In our project, we digitized the underlying establishment-level data for the years 1863 to 1900, which form the backbone of this thesis.[25] To collect the material, we first digitized the underlying documents in collaboration with Riksarkivet (for the years 1863 to 1895) and ArkivDigital (for the years 1896 to 1900). Experts familiar with Swedish economic history and reading old Swedish handwriting then translated this information into digital form. Almås et al. (2022) discuss this procedure in more detail.



(a) 1860 (b) 1888 (c) 1900

Figure 10: Examples of the raw material
Notes: The figures show the digitized forms for Bolinders Mekaniska Verkstad for various years.

[25] There is a slight difference in how the data were collected before and after 1896. For the years before 1896, the local statistical offices tasked establishments to report information on the specified variables. In turn, the establishments reported this information in letters sent to the local statistical offices, which transferred the data into specified forms. We extracted the information from these forms and cross-checked the results with the information—where available—contained in the letters. From 1896 onward, each establishment received a specific questionnaire, which we digitized.

3.2 Definitions and Concepts

As described above, Sweden's National Statistical Office surveyed manufacturing establishments and collected Fabriksberättelserna to assess the country's economic and industrial development. Ultimately, this approach necessitates defining what *establishments* and *industry* mean in this context. Essentially, the design of the data collection implies that an establishment refers to one unit of production occurring in the same place and (in a similar) industry over time. By focusing on establishments, Fabriksberättelserna are similar to American historical manufacturing data (Atack and Bateman, 1999), and a broadly similar term for establishments would be *manufacturing plants*.

As such, this thesis essentially follows the definition of establishments used by the Swedish National Statistical Office when compiling the data. Yet, as further outlined elsewhere in this chapter and the respective papers, my data contain many small establishments that employ only one or two workers. Thus, one could wonder whether such establishments should be regarded as artisans—i.e., a master with possibly a few apprentices working in a skilled trade—instead of manufacturing establishments.[26] Indeed, separate data on (Swedish) artisans exist, and the boundary between artisans and manufacturing establishments was (somewhat) blurred when collecting the data. Consequently, the allocation of small units of manufacturing production to either the artisan or manufacturing sector was, at least in some cases, arbitrary (Key-Åberg, 1898).

Against this background, it is important to emphasize that I am essentially following the resulting (official) distinction by the Swedish National Statistical Office between manufacturing establishments and artisans. Nevertheless, this leaves me with the choice of disregarding small manufacturing establishments in my analysis, as they should potentially be regarded as artisans instead. As this would mischaracterize the state of the Swedish manufacturing sector during the nineteenth century, I generally include all manufacturing establishments—that the enumerators classified as such—in my empirical analysis. In any case, my results are generally not driven by the presence or absence of tiny establishments. For example, in Paper II, the postulated mechanisms also hold between establishments of medium compared to large size. Conversely, harmonizing the artisan and establishment-level data could be a fruitful avenue for future research.

Two further issues arise when using the definition of industrial establishments as discussed above. First, a little less than 10 percent of all observations refer to establishments that consist of multiple business units, for example, a clothing factory with an adjacent dyeing factory. As it is not possible to further distinguish between these separate units, I collapse this information to the establishment level. Yet, it is important to note that this does not corrupt my focus on establishments. It just implies that some establishments consisted of multiple units, which resembles how (some) establishments organize themselves also today. A second thing worth highlighting is that my focus on establishments does not (necessarily) correspond to ownership structures. As such, multiple establishments can be

[26]Note that for this reason, we specifically focus on *artisan shops* and not *artisans* in Paper I.

owned by one firm, and this is unknown to me. However, this unlikely biases my findings as we show in Paper II that relatively few establishments were jointly owned throughout the period of analysis. Overall, identifying firms among the establishments in the panel could also be a fruitful avenue for future research.

A key benefit of my data is that in contrast to modern industrial censuses (e.g., Iacovone, 2012), the Swedish industrial statistics did not require establishments to be of a minimum size to be included in the data (before 1913). Instead, establishments only needed to be part of the industrial sector according to the definition of the country's statistical office (Jörberg, 1961, pp. 367–382). Ultimately, this necessitates defining what *industry* refers to in this context. While it might sound straightforward to define which business activities are industrial—i.e., one generally distinguishes between mining, manufacturing, construction, utilities, transportation, and communication (Chandler Jr., 1990; Kuznets, 1971)—especially from a historical perspective, it is not. While numerous business activities occurred in late nineteenth-century Sweden, the boundaries between artisanal and industrial activities were blurred (Jörberg, 1961, p. 372). Moreover, industrialization involved the creation of entirely new activities. As such, the list of which business activities were considered industrial—and are thus covered in my data—gradually expanded. Section 3.4.3 explains these changes in further detail, arguing that they are not of a magnitude significant enough to influence the findings of my thesis.

Currently, my data contain information on business activities from 12 (manufacturing) industries, which are based on the industrial classification used in the Swedish industrial statistics BiSOS D in 1900 (SCB, 2019a). The names of the industries are the following: Food/Beverages, Textiles, Leather/Hides/Hair, Oil/Tar/Rubber, Wood, Paper, Plant-Based Products, Clay/Stone/Coal/Peat, Chemicals, Metals, Machinery/Instruments, and Graphical Products. To arrive at this classification, we compare the business activity of each establishment as stated in their respective return with the industrial classification from BiSOS D in 1900 (SCB, 2019a).[27] As I further discuss in Section 3.4.3, a key benefit of my data is that no major reorganizations occurred within the 12 industries, so the coverage of establishments within these industries for the period of my analysis is arguably complete.

However, by focusing *only* on these 12 industry groups, my analysis naturally leaves out certain business activities, which were historically important and that we today generally classify as industrial (Chandler Jr., 1990; Kuznets, 1971). These include, for example, sawmills, ironworks, and mining. While it is unfortunate that I do not have information on these historically important business activities (as also sketched above), it is important to restate that their absence from my data is not a failure of the data collection itself. It simply reflects that Sweden's statistical office did not consider these business activities industrial during my analysis period. For example, Kommerskollegium considered sawmills until 1896 as part of the forestry sector (Jörberg, 1961, p. 377). While this might seem in

[27] As the papers discuss in further detail, one establishment can also be active in multiple industries. Overall, different robustness checks in the papers show that this is not driving the findings.

retrospect like a misclassification, it explains why (important) business activities are left out of the Swedish industrial statistics and, therefore, my analysis.

An implication of this circumstance is that my data should not be used for national accounting, as by design, my data cannot accurately reflect Sweden's aggregate national output.[28] However, this is not problematic for my analysis as I am not interested in analyzing the aggregate economic development of Sweden. My thesis aims at analyzing establishment-level growth dynamics, so I am focusing on changes within establishments. Crucially, for this purpose, not all possible industries of interest need to be covered in the data. Under the assumption that the establishment-level growth dynamics are roughly similar across industries, adding further industries would leave my conclusions unchanged.

Instead, for my purposes, it is primarily necessary that within the targeted industries, the establishment-level information is accurate. As the next sections show, this is arguably the case. Moreover, it can be argued that my data contain information on many important industries—e.g., textiles, paper, and chemicals—both for Swedish economic development and, more broadly, the Second Industrial Revolution (Chandler Jr., 1990; Kuznets, 1971). Therefore, adding the remaining industries from other archival sources should primarily be seen as fruitful avenues for future research. More broadly, this issue is not restricted to my Swedish manufacturing data, as also the American manufacturing census was expanded to cover more industries over time. As such, for example, Atack (1987, p. 293) "focuses upon sixteen industries that were among the more important in the nineteenth century." Overall, despite its caveats, my data remain novel, unique, and suited to analyze establishment-level growth during industrialization.

3.3 Linking Establishments over Time

While the Historical Manufacturing Census of Sweden is rich in detail, it lacks an identifier to trace individual establishments across years.[29] My key contribution to the construction of the data set is to create such a panel identifier. To trace the same establishment over time, I develop an algorithm drawing on automatic record linkage techniques.[30] This section describes the underlying process, which takes three steps: (i) data cleaning, (ii) linking of

[28]Several authors reconstruct Swedish GDP estimates at the aggregate level and for different sectors (Edvinsson, 2013; Hamark and Prado, 2022; Krantz and Nilsson, 1975; Krantz et al., 2007; Lindahl et al., 1937a,b; Schön and Krantz, 2015). While these data show how the aggregate Swedish economic development, they are not free of assumptions and/or imputations as discussed by the respective authors. This resembles the truism that all data have their peculiarities.

[29]As the linking procedure is aimed at identifying the same establishment over time, it is important to note that it cannot be used to identify mergers or acquisitions between establishments. As such, the precise reason for establishment-level exit is unknown. While this can sound problematic, similar historical manufacturing data, for example, for Imperial Russia, face the same problem (Gregg and Nafziger, 2020). While allowing for the identification of mergers and acquisitions is arguably a fruitful path for future research, it is important to highlight that mergers and acquisitions remain a specific type of establishment-level exit. Thus, adding such information would only allow for more detailed analyses.

[30]I thank Olof Ejermo and Björn Eriksson for their guidance in this undertaking.

the data using automatic record linkage techniques, and (iii) manual checks.[31] As further discussed below, how the underlying information was collected changed in 1896. As such, I first link observations for the years 1863 to 1895 and later observations for the years 1896 to 1900 while simultaneously allowing for links across the years 1895 and 1896. This section outlines the general procedure for linking both periods while discussing differences in the underlying algorithms.[32] More details regarding the construction of the panel identifier can be found in Almås et al. (2022).

Cleaning the data: To more accurately link establishments over time, it is necessary first to clean the data. To do so, within the project, we first identify a subset of observations that do not refer to an establishment but to different units within a given establishment (in Swedish *Summa Fabriker*). Such cases represent less than 10 percent of all observations, and we manually link them. To increase the precision of the linking, I next clean the names of the owners and establishments. This involves, for example, the removal of certain abbreviations in the names of establishments such as *& Comp.*, *& son.* or *Ltd.*. I also remove the suffix *-son* from the names of individuals since it is a common ending of many Swedish names and consequently provides little helpful information in distinguishing between them. Effectively, this cleaning enables the algorithm to better differentiate between names to link establishments.

Algorithm linking the data: To link the establishment-level observations over time, I develop an algorithm based on automatic record linkage techniques. This algorithm is similar to previous work that aims to link individual people across different census years (e.g., Abramitzky et al., 2012; Eriksson, 2015; Ruggles, 2002). Intuitively, such approaches link two different observations over time to denote the same establishment if (i) the observations are *sufficiently* similar in terms of variables that should remain constant over time—e.g., the location, industry, and name of establishments as well as the name(s) of their owner(s) and manager(s)—and (ii) there is no other possible match according to a set of previously specified criteria. However, a difficulty is that while, for example, the name of establishments *should* be the same over time, in practice, it can vary, for example, due to spelling errors

[31]An implicit check regarding the accuracy of the linking is to look at the aggregate entry and exit rates of establishments. As shown in Appendix Figure A.4, they averaged between 5 and 10 percent per year, respectively. While noticeable, these rates are not of unreasonable magnitude as they are similar to estimates for industrializing Russia and contemporary Western countries (Gregg and Nafziger, 2020). As such, we are unlikely to fail to link a substantial number of establishments.

[32]One issue in linking both parts of the data together is that some establishments might be active around, for example, 1890, then inactive for some time, and active again after 1896. I account for this possibility by allowing establishments in 1896 to be linked to establishments between 1890 and 1895, with possible gaps in between. Also, the manual checks discussed below ensure that the transition between the years 1895 and 1896 is correct.

or mistakes in the general handling, transcription, and digitization of the data.[33] Also, the names of individuals or places may change and/or a change in ownership may occur. Given these difficulties, the central aim of the algorithm is to link observations together into—as further defined below—*highly similar* blocks. These blocks are manually checked by experts familiar with the histories of Swedish establishments and corrected if necessary. This involves both the correction of automatically created links and the addition of links in case they were not automatically created. Thus, on the one hand, if the experts deem that linked observations do not refer to the same industrial activity by the same establishment in a concrete location, they create separate blocks. On the other hand, if the experts identify two blocks of observations covering different years that plausibly identify the same place of industrial activity, they link both blocks. This is useful, for example, if the name of a given place changes. While such changes are unknown to the algorithm, experts on Swedish economic development are familiar with them.

To assess whether, for example, the name(s) of an establishment or its owner(s) and manager(s) are *highly* similar, I mostly rely on so-called Jaro-Winkler distances (Winkler, 1994), following previous approaches by, for example, Ruggles (2002), Abramitzky et al. (2012), or Eriksson (2015). Intuitively, a Jaro-Winkler statistic measures the similarity of two strings by calculating the number of changes required to convert one string into the other. This distance is then normalized on a scale ranging from zero to one—a value of one implies that two strings are identical—and weighs spelling differences at the beginning of both strings higher than those at the end (Feigenbaum, 2016). This weighting is, for example, motivated by the possibility that the collectors of the data tended to be relatively more accurate when writing the beginning of a name.

The general approach of the algorithm to automatically link establishments across years is as follows. The algorithm starts in the first year t_1—i.e., 1863—and keeps all observations from this year. Then, each of these observations is compared with all observations from the next year t_2, which is in this case 1864. Two observations are linked, and a match is created if (i) this match is unique and (ii) the observations are similar in terms of their industry, location, and factory or owner name. I use a threshold of 0.9 to classify two strings as similar, which follows work by, for example, Eriksson (2015).[34] This value can also be justified by the fact that moving too far away from one as a threshold increases the number of links that arguably do not refer to the same establishment. Taking a value of 0.9 is, thus, more conservative in that fewer links are created, which then need to be manually linked together. Indeed, relatively few manual corrections refer to the correction of false links within the blocks of observations. In contrast, most corrections are needed to link blocks of observations together. Overall, we interpret this more cautious approach in which all observations are ultimately also manually checked as a strength.

[33]Similarly, in some cases, only the initials of the owner(s) are recorded in the first year, while the second year contains their full name(s).

[34]In case initials instead of first names are stated, initials have to be identical for a link to be created as further discussed below.

Crucially, the algorithm does not create a link if (i) two observations from the first year could plausibly be linked to the same observation in the next year or (ii) one observation from the first year could plausibly be linked to two observations in the next year. The code then replicates this procedure based on the next period t_1 and all following years $t_3, \ldots, t_n$. Afterward, the code starts continuous loops over all other years, beginning in t_2. Again, in this procedure, only unique matches are kept, and it is replicated until all years are covered.

Given the nature of the data, in some cases, an automatic match is not created even though it should have been. This happens, for example, if the owner's name was recorded in the correct field in the first year but recorded as the name of the establishment in the next year. To still create an automatic link for such cases, I combine the owner name and establishment name into one string and compare the resulting string over time using the Levenshtein distance and the same threshold of 0.9.[35] Here, I use the Levenshtein instead of the Jaro-Winkler distance as it does not weigh differences in the spelling in the latter part of the names down. Only observations that were not linked in the first step are included in this procedure.

Differences in the linking across periods: While the previous paragraphs describe the general linking approach, it slightly differs before and after 1896 due to differences in the underlying data. As there is no information on the names of the manager(s) of a given establishment before 1896, only information on the owners is used in the linking of the years 1863 to 1895. Here, I additionally distinguish owners by their first name(s), which can either be stated as a full name or initial(s). I link establishments over time by leveraging information on the first owner and building an indicator assessing how well the first name(s) map over time.[36] This indicator ranks potential links based on full first names in both years higher than links between a combination of full first names and initials. Links based only on initials are ranked lowest.

The data after 1896 also state the manager(s) and leaseholder(s) of an establishment. I add these names to the column containing the owner(s) and use the information on the first three people contained in this column for the linking.[37] Here, I allow for the possibility that, for example, a person is an owner in one year but a leaseholder in the next. Again, I link two observations if the last and first name(s) are similar across years for at least one

[35]Here, the strings denoting the location and industry still have to be similar in terms of the Jaro-Winkler distance.

[36]Note that establishments can still be linked through their respective name. For simplicity, I only use the name of the first owner when linking based on the owner's name. Also, I only include up to three first names in this procedure. This is because most owners have only one first name.

[37]Few establishments have more than three people reported in this column. For simplicity, I do not build an indicator distinguishing between initials and full names here compared to the approach above. Instead, I compare the strings directly.

person. If this is not the case, I still allow for a link if only the last names are similar. This allows for cases where, for example, a son took over an establishment.[38]

3.4 Evaluating the Accuracy of Fabriksberättelserna

This section critically evaluates Fabriksberättelserna as a source. First, I argue that while the data admittedly have some weaknesses, the variables that I rely on accurately capture what they are supposed to measure. Second, my review shows that while Fabriksberättelserna do not contain all possible industries of interest, they consistently capture establishments in industries important for Swedish and the general economic development over the latter half of the nineteenth century. As such, Fabriksberättelserna are highly useful for academic study.[39]

3.4.1 Accuracy of the Data

Generally, a certain skepticism has been voiced against the accuracy of the variables contained in Fabriksberättelserna. However, when critically evaluating the data, it becomes apparent that such skepticism is often overstated (Jörberg, 1961, p. 369). First, reforms in 1863 and 1896 greatly improved the collection of Fabriksberättelserna. Second, there are generally few discrepancies when comparing the information contained in the manufacturing census with the account books of a selection of individual establishments (Jörberg, 1961, pp. 367–382). Almås et al. (2022) replicate such exercises for selected important manufacturing establishments—e.g., Atlas, Bolinders, and Kockums—showing that Fabriksberättelserna closely match the internal account books of selected important establishments. In what follows, I critically discuss the accuracy of the main variables of interest and outline their usage in the respective papers.

[38]There are several additional improvements to the linking for the second period. Originally, I only link observations with a unique match based on either the factory or owner name. As such, cases where one company owns multiple establishments in a similar location would need to be manually linked. In the second period, I can use the information on, for example, manager(s) to sort out these cases better and automatically link them. Also, I use the information contained in the industrial codes in the linking if no match is found based on the strings that describe the industry in which an establishment was active. Lastly, observations without a recorded location are linked to observations with a reported location if there is otherwise no match.

[39]Additional to the evidence presented in this section, Almås et al. (2022) present further evidence showing that Fabriksberättelserna can be used for econometric analysis. For example, we show that the number of workers reported in Fabriksberättelserna closely matches the one reported in the population census within industry-region-year cells. One issue with historical manufacturing data is that part-year operation was often the norm during industrialization (Atack et al., 2002; Gregg and Matiashvili, 2022). In the absence of concrete information to identify establishments that operated for only parts of the year, I have not made any special corrections. Yet, from my results in Paper I, it can be inferred that it is unlikely that part-year operation influences my results to a large extent. If anything, artisan shops active in the early years of my period of analysis should have been more likely to operate for only parts of the year. This should render them relatively more likely to exit than, for example, factories. However, this contradicts our observation in Paper I that the distinct survival advantage of factories emerged only over time. Atack (1987, p. 292) provides a similar justification.

Workers: One key variable of interest is the total number of workers in each establishment. This information is, in many cases, further broken down into the number of male and female employees that live at the factory or elsewhere (in Swedish *mantalsskrivna*). Also, the number of child laborers is generally included in the statistics. A potential problem regarding the accuracy of this information is that the number of workers can fluctuate over the course of a year. After 1896, establishments were mandated to state the average number of employed workers per year, while it remains unclear whether this rule was also applied before. Based on a careful evaluation of the aggregate industrial statistics, Jörberg (1961, pp. 374–375) concludes that the growth rate of reported workers between 1895 and 1896 was not exceptionally high, suggesting that even before 1896, establishments reported the average number of workers employed in a given year. This conclusion is reinforced when directly using Fabriksberättelserna. Appendix Figure A.6 shows that the median establishment-level growth rate and the number of workers per industry and year did not appreciably change during the 1890s. Thus, changes in accounting practices are unlikely to bias the reported number of workers.

A further potential complication and open question is whether the number of workers refers to blue-collar workers or includes white-collar workers. This question is motivated by the fact that both types of workers were separately stated in the national statistics after 1913, making it unclear how the number of white-collar workers was previously treated. Indeed, there is evidence that the national statistics before 1913 do not include white-collar workers when reporting the total number of establishment-level workers.[40] Thus, by extension, it is possible that I undercount the number of establishment-level workers also in my data. However, this is unlikely a big issue as before 1900, the share of white-collar workers was below 5 percent and, thus, generally low (Carlsson, 1968, p. 257). Moreover, it is arguably the case that white-collar workers were more likely to work in larger establishments. As their total number was limited, it is questionable whether this potential undercounting is of practical relevance when, for example, calculating labor productivity.

Sales: Together with the number of workers, the establishment-level sales—or production value as it is called in the original forms—is a key variable of interest in my study.[41] It is possible that the methods used to count sales differ over time. In general, it was specified that the production value corresponded to the value of sales that left the establishment. However, in 1896 it was decided that establishments should separately state the production value of semi-manufactured goods used for further processing in the same establishment or other establishments. Consequently, it is unclear if the value of sales before and after 1896

[40]This conclusion builds on the observation that while in 1911 the total number of industrial workers in Sweden was 304.586, this number rose to 310.437 in 1912 but to 391.618 in 1913 when adding white- and blue-collar workers together (Kommerskollegium, 1913, 1914, 1915). However, a change in the industrial classification in that year can compromise these comparisons as well.

[41]Unfortunately, the data do not contain information on production costs. For simplicity, I generally use the term *sales* instead of *production value* in the thesis.

are comparable (Lindahl et al., 1937b, pp. 180–181). As only Paper III uses data from 1896 and onward, this change in accounting procedures is unlikely to generally influence my results. Regarding Paper III, Appendix Figure A.7 shows that the main conclusion holds when only using data for the years 1891 to 1895. Moreover, by comparing the production values with the internal accounts of a selected number of establishments, Jörberg (1961, p. 376) finds that production was generally accurately recorded in Fabriksberättelserna.

A related issue is that sales potentially include the value of inputs. Thus, when interested in calculating national totals, there will be a general double counting (Lindahl et al., 1937b, p. 181). However, this is less problematic when leveraging variation within establishments, assuming that the share of inputs remains constant within establishments over time. Then, conclusions about the development of production can be made. The observations that only Paper III uses the information on sales to a greater extent and the period of analysis in this paper is relatively short increase the plausibility of this assumption. In addition, I use profits as robustness checks and rely on the number of workers when differentiating establishments by size.[42]

Labor productivity: Using the information on the number of workers and sales, I calculate my preferred measure of yearly establishment-level labor productivity as $ln(Sales/Workers)$. This approach is similar to previous work in the field (Atack et al., 2008; Gregg, 2020). I also follow previous work by Gregg (2020) in calculating a measure of total factor productivity (TFP). The observations above that sales and workers are accurately measured add to the plausibility of using this variable.

Technology: The data also state whether an establishment used steam, water, and/or animal power. In later years, also the usage of electricity was reported. Yet, the forms used to collect data on technology use were somewhat ambiguous, which did not make it immediately clear to owners of establishments what they should report. Regarding the reliance on animal power, for example, some establishments stated how many of their treadwheels were powered by animals, whereas others stated how many animals they used to run treadwheels (Jörberg, 1961; Key-Åberg, 1898). To harmonize and use this data, I only focus on the extensive margin that measures whether establishments were using, for example, *any* steam power but not the actual number of installed steam engines. While the data contain further information on establishment-level horsepower and the number of tools available, this information is generally not appropriate for analysis (Jörberg, 1961, pp. 367–382). Consequently, it is not used in this thesis.

Missing observations: While the Historical Manufacturing Census of Sweden is very encompassing, naturally, sometimes observations are missing for certain establishments. This

[42]Another issue is that relative price movements can distort the value of sales over time. Where applicable, I include industry-by-year fixed effects to flexibly account for differential price trends across industries. Additionally, in Paper III, I deflate the value of sales using a series developed by Ljungberg (1990).

can be due to various reasons, for example, enumerators could have forgotten to survey some establishments in a given year, data was lost or not transcribed, or while there is general information on the establishment, it is missing for certain variables. As argued in the respective papers, missing observations refer to only a small share of all available information, so this is likely a minor issue. Moreover, I show that restricting or expanding my sample according to different criteria produces largely similar results. Regarding Paper II, for example, while I generally restrict the analysis to establishments with a unique industry, expanding this definition to include establishments that operate in multiple industries does not affect the conclusions. Similarly, while I generally drop observations where the number of workers is not reported, following, for example, Atack et al. (e.g., 2008), including them does not change the results.

3.4.2 Coverage Within Industries

As discussed above, the Historical Manufacturing Census of Sweden consists of 12 industry groups. This section demonstrates that *within* these industry groups, the coverage of the manufacturing census is extensive so that the data can be used for academic study.

In principle, all establishments within the 12 industries should have been surveyed by local enumerators and thus be covered by the Historical Manufacturing Census. Naturally, it is questionable whether this was indeed the case as establishments faced sanctions for not returning information only after 1896 (Key-Åberg, 1898). Such concerns have been amplified by the fact that revisions of the national statistics in 1891 and 1892 found 504 establishments that were previously obliged to submit returns but which had failed to do so (Jörberg, 1961, pp. 369–370).[43] However, such concerns are likely overstated. While Jörberg (1961, pp. 372–373) argues that it is practically not feasible to survey whether all establishments were included, he demonstrates that especially larger establishments were covered well by the manufacturing census.[44]

Almås et al. (2022) provide two additional robustness checks showing that the data accurately capture establishments within industries. First, we show that there is a close fit between employment patterns in industry-region-year cells when comparing the manufacturing census with the Swedish population census. Second, for certain industries, other data exist that were separately collected and can be used to check Fabriksberättelserna. As

[43]A promising avenue for future research is to complement our data with, for example, archival sources from these establishments for the years they are not covered. However, it was not possible to do this in the realm of this thesis. Overall, it is unlikely that the absence of this information overturns my main conclusions. As I mainly leverage within establishment-level variation, the dynamics within the missing establishments must have been quite different from the other Swedish manufacturing establishments. As this is unlikely the case, adding such information would likely only strengthen my conclusions.

[44]Potentially, this could drive our results in Paper I that (manu)factories survived relatively longer than artisan shops. However, under the assumption that smaller establishments were *always* less likely to be covered, the fact that we find a gradual realization of the benefits of the factory system over time speaks against this hypothesis.

such, it is possible to compare our data on matchmakers with separately collected data, which shows a close fit.

As a further indirect test concerning the coverage within industries, I use the introduction of fines in 1896 (Key-Åberg, 1898) to see whether the number of establishments per year and industry *notably* differs before and after. While this evaluation ultimately depends on some degree of subjective judgment, a fair assessment of Appendix Figure A.8 is that the number of observations did not appreciably change around 1896 within three important subindustries: dyeing, clothing, and tobacco. As such, within industries, establishments are arguably accurately covered.[45]

3.4.3 Changes of Surveyed Industries

As discussed above, this study inherits its definition of *industry* from the Swedish national statistics, which were published in aggregate form based on the establishment-level surveys used in this thesis. As industrialization entailed the creation of new activities, the national statistics correspondingly expanded their definition of *industry* over time. As such, this could affect how well my panel of establishments is balanced. Thus, it becomes necessary to evaluate (i) which subindustries were added to the 12 industry groups and (ii) how these changes affect the conclusions reached in this study.

For the period before 1896, Lindahl et al. (1937b, pp. 174–175) state the years when subindustries were added to the aggregate Swedish industrial statistics. Among them were, for example, breweries (1872), brickworks (1873), fish-curing establishments (1891), and distilleries (1892). At first sight, the fact that industries were added to the aggregate industrial statistics poses a potential problem regarding the balancedness of my establishment-level panel. Yet, while these industries were added to the aggregate data, it is also possible that they are, in fact, accurately covered in the establishment-level surveys. After all, enumerators rather loosely included establishments they deemed industrial in their surveys, which were then disregarded when aggregating the data (Jörberg, 1961; Key-Åberg, 1898). On this account, the coverage and balancedness of my establishment-level panel could be much better.

To distinguish between these two possibilities, Almås et al. (2022) compare how many establishments were added per subindustry in the specified years according to Lindahl et al. (1937b, pp. 174–175) with the number of establishments reported in Fabriksberättelserna around these years. This comparison reveals that, even though subindustries were added to the national aggregate statistics, the individual returns per establishment (generally) existed in Fabriksberättelserna even before the subindustries were added at the national level. This reduces concerns about the balancedness of my data and implies that the national statistics

[45] I selected these subindustries since relatively many establishments existed in them already in 1864 Kommerskollegii (1864) and—in contrast to other subindustries—the wording to denote these activities did not notably change over time. As further outlined in Appendix Figure A.8, the number of establishments contained in my data matches quite closely the one reported in the aggregate statistics, further reinforcing the trustworthiness of my data.

disregard some data collected by the local enumerators. An example is useful to highlight this point. While Lindahl et al. (1937b, pp. 174–175) state that 44 breweries were added in 1872 to the national statistics, our data show 47 breweries in that year but also 42 breweries already in 1871. Overall, these comparisons reveal that the gradual inclusion of subindustries prior to 1896 unlikely affects my results. This is further strengthened when only analyzing data for the years before 1890, which Papers I and II do. For this period, Almås et al. (2022) conclude that only gasworks were really added to the statistics, which we do not observe previously in the establishment-level data. Yet, those are only 24 establishments in 1874 that we fail to trace in previous years. As Papers I and II use information on more than 6,000 establishments, this circumstance unlikely influences any results.

Another reorganization and expansion of the national statistics occurred in 1896 with the addition of several subindustries. Among them were, for example, sawmills and flour or grain mills Lindahl et al. (1937b, p. 177) and later mining (Jörberg, 1961, p. 369). Almås et al. (2022) conclude that these subindustries were indeed added to the manufacturing census even though returns for some of such establishments exist also before 1896. As the first and second papers do not analyze this period—and Paper generally III focuses on a set of establishments existing in 1891 and later—such changes do not affect the stated conclusions.

How does the absence of information on certain industries influence the findings of this study? On the one hand, data for many industries prior to their addition to Fabriksberättelserna are available, which could be a fruitful avenue for future work. On the other, the impact of not having such data on the results of this study is likely limited. As outlined above, the absence of this data primarily limits the usefulness of my data when aggregating it to study economic developments at the national level. However, my main research interest lies in analyzing (growth) dynamics within establishments. As the previous sections show, my data is well suited for such purposes. Under the assumption that the dynamics within establishments in industries not covered by my data are similar to the covered industries, adding more information would again leave my results unchanged.

3.5 Other Data

Depending on the research purpose, I add to the Historical Manufacturing Census of Sweden data from various sources. As these data are introduced and discussed in more detail in the respective papers, this section only briefly reviews them.

To study the effects of tariff policy on establishment-level outcomes, I rely on tariff data compiled by Persarvet (2019). As this data is available on yearly basis for individual industries, it can be easily merged with the establishment-level data. As a proxy for the relative innovativeness of establishments and industries, I use in Papers I and III patent data recorded by the Swedish Patent and Registration Office (PRV), which are taken from Andersson et al. (2023). As Papers I and II highlight, differences in ownership can affect establishment-level performance and outcomes. To document such effects, I distinguish be-

tween (sole-)proprietorships and corporations. While it is possible to identify corporations directly from my main data source since it states the respective name of establishments, I complement this information with data from the Swedish incorporation registers from 1875 and 1882 (van der Hagen and Cederschiöld, 1875, 1882).

Finally, the last chapter has a broader focus as it analyzes the consequences of industrial growth on the service sector across the United States, Great Britain, and Sweden. Here, I use census data taken from the IPUMS project for the respective countries (MPC, 2019; Ruggles et al., 2021) and harmonize this information across regions and sectors.

3.6 Methodology

This dissertation employs a quantitative approach to answer the posed research questions. While I mainly rely on descriptive statistics as a motivation for each paper and to sketch historical trends observed in the data, I follow a growing trend in Economic History by using econometric methods developed to causally identify drivers of economic change (e.g., Abramitzky, 2015; Margo, 2018). As the nature of the research problem in each paper differs, I employ various quantitative methods. Each paper further outlines and explains its methods and their underlying assumptions. As such, this section only serves as a brief summary.

In Paper I, I am interested in analyzing the determinants of establishment survival. To do so, I mainly rely on Cox proportional hazards models, which are among the most widely used methods for survival analysis and borrowed from epidemiological research. In the remaining papers, I mainly use two-way fixed effects models, the first-difference estimator, and difference-in-differences approaches to causally identify the parameters of interest. Following a growing literature analyzing the properties and issues of the difference-in-differences estimations (e.g., Goodman-Bacon, 2021), I also rely on state-of-the-art difference-in-differences estimators developed by Callaway and Sant'Anna (2020) and Sant'Anna and Zhao (2020). Finally, I follow previous work by, for example, Moretti (2010) or Gregg (2020) with the usage of instrumental variable (IV) techniques, where applicable.

4 Findings and Results—Summaries of Papers

This section presents the findings and results of this thesis through an executive summary of each paper.

4.1 Firm Survival and the Rise of the Factory

This paper is co-authored with Thor Berger

One of the defining features of industrialization was the shift of production toward the large factory, which is here defined based on previous literature as an establishment relying on

mechanized production using steam or water power (Atack, 1985; Laurie and Schmitz, 1981; Sokoloff, 1984). Yet, a revisionist literature highlights that also smaller non-mechanized establishments—e.g., artisan shops—remained efficient and competitive during the Second Industrial Revolution (Berg, 1994; Marglin, 1974; Schön, 2012; Sokoloff, 1984). While different types of producers were responsible for industrial production, we lack quantitative evidence on how the relative performance of these different forms of industrial organization compares.

In this paper, we use Fabriksberättelserna to study the life cycle of three types of establishments that characterize late nineteenth-century industrial organization. Following previous work (Atack, 1985; Laurie and Schmitz, 1981; Schön, 1979), we distinguish between factories—defined as establishments using steam or water power as a central power source to mechanize production—as well as manufactories and artisan shops, which are larger and smaller non-mechanized establishments, respectively.[46] Using these definitions, we begin by charting the rise of the factory in late nineteenth-century Sweden. While most establishments became organized as factories during this period, we show that also small plants persistently existed during industrialization. Moreover, the rise of the factory was driven by an increase in the number of factories but not necessarily a decline in the number of manufactories and/or artisan shops. This is consistent with evidence from the USA, where before the advent of the railway, local markets were naturally protected, leading to the continuous persistence of smaller establishments (Atack, 1985, 1986, 1987; James, 1983; Sokoloff, 1984; Ziebarth, 2013).

Next, we distinguish between three possible dynamics that can lead to the relative rise of the factory: entry, conversions, and survival. We first document that while the share of factories among entering establishments increased over time, entering establishments were always less likely to be organized as factories relative to incumbent establishments. Second, the rate of establishments converting into factory form remained relatively constant and small over our analysis period. As such, we conclude that entry and conversions cannot explain the relative rise of the factory observed during our analysis period. Therefore, the underlying root cause must be a relatively longer survival of factories relative to artisan shops and manufactories.

Using Kaplan-Meier curves and Cox proportional hazards models, we document that factories had a survival advantage relative to non-mechanized establishments, which increased as industrialization progressed. While this result reflects the advantage of factory production, we also highlight that manufactories—i.e., non-mechanized establishments leveraging some gains from the division of labor—possessed similar survival advantages relative to small establishments, remaining competitive at least in the early stages of industrialization. As such, our results are consistent with arguments by Sokoloff (1984) and Atack (1987).

[46] We use a cut-off of seven workers to distinguish between small and large establishments, following (Atack, 1985; Laurie and Schmitz, 1981).

We next distinguish between five leading explanations—scale (e.g., Langlois, 1999; Okazaki, 2021; Sokoloff, 1984), technology (Atack et al., 2008, 2022; Jones, 1987), ownership characteristics (e.g., Gregg, 2020; Hilt, 2015; Landes, 1969), employment characteristics (Eriksson and Stanfors, 2015; Goldin and Sokoloff, 1982, 1984; Heikkuri et al., 2022), and urbanization (Kim, 2006; Rosenberg and Trajtenberg, 2004)—to explain why factories survived relatively longer. While we document that larger non-mechanized establishments achieved some survival gains during the early phases of industrialization, technology became a key determinant for survival once industrialization became more firmly rooted. Other factors, such as corporate ownership, only indirectly affected survival, for example, by contributing to the diffusion of steam technology and increasing establishment-level size. Consequently, a key question is how establishments overcame constraints to growing in size and adopting new technologies. The subsequent papers analyze such questions, drawing on econometric techniques to identify causal effects.[47]

4.2 Institutional Change and the Adoption of New Technologies: The Case of Steam

This paper is co-authored with Thor Berger

The first paper of this dissertation analyzes the correlates of establishment-level survival, pointing to a key role of technology and establishment-level size. While novel technologies often have the potential to increase establishment size and productivity, thereby contributing to aggregate growth and development, a stylized fact is that many new technologies diffuse slowly (Hall, 2004; Hall and Khan, 2003; Mansfield, 1961; Rosenberg, 1972). This is particularly true for the paradigmatic technology of the Industrial Revolution—i.e., the steam engine—(Crafts, 2004b), which has been explained due to differences in the availability of coal (Kanefsky, 1979; Nuvolari et al., 2011; von Tunzelmann, 1978), slow technological improvements (Crafts, 2004b; Nuvolari and Verspagen, 2009; von Tunzelmann, 1978), and the prevalence of small establishments where adoption was not profitable (Atack et al., 2008).

We study whether the advent of the modern corporation contributed to the diffusion of steam power by helping establishments to overcome constraints in terms of their size. Prior to its industrial takeoff, the Swedish economy was essentially liberalized along several dimensions (Schön, 2012, pp. 82–93) so that, for example, the process of incorporation became a system of mere registration (Nilsson, 1959). In turn, incorporation plausibly reduced the risks associated with making major capital investments, such as adopting steam (Gregg, 2020).

Drawing on two-way fixed effects and event study estimates based on recent advances in the difference-in-differences literature (Callaway and Sant'Anna, 2020; Sant'Anna and

[47] A related question is to what extent (new) factories drove out artisan shops and manufactories. An explorative analysis at the county level did overall not substantiate the presence of such effects. Yet, using a more fine-grained regional division, it is possible to analyze such channels in future research.

Zhao, 2020), we show that incorporation sharply and persistently raised the probability of establishments adopting steam technology. We find this holds especially for more marginal establishments—i.e., smaller establishments located in rural areas with worse access to banking. We argue that incorporation allowed especially these marginal establishments to finance their expansion to a size where it became profitable to adopt steam. More broadly, our results highlight that the liberal Swedish incorporation system (Nilsson, 1959) had more widespread effects in driving industrialization when compared to that of, for example, Imperial Russia, where incorporation was costly and held back industrial growth (Gregg and Nafziger, 2019; Gregg, 2020).

By providing the first establishment-level and longitudinal study to link the advent of the modern corporation to the diffusion of steam technology, we contribute to several strands of literature. First, previous studies regarding the diffusion of steam technology have relied on regionally aggregated data (Atack et al., 1980; Bogart et al., 2017; Gutberlet, 2014; Nuvolari et al., 2011), whereas our linked establishment-level data enable us to directly observe the choice of organizational form and its effect on technological change. Second, our findings underscore the importance of the modern corporation as an institutional innovation for industrial development (Chandler Jr., 1977, 1990; Foreman-Peck and Hannah, 2015; Gregg, 2020; Guinnane et al., 2007; Hilt, 2006; Prado, 2014; Rosenberg and Birdzell Jr., 1986).

4.3 Winners and Losers: The Asymmetric Impact of Tariff Protection on Late-Nineteenth-Century Swedish Manufacturing Firms

Next to incorporation, another key example of economic policy aimed at promoting industrialization and the growth of manufacturing establishments was the sharp increase of import tariffs across countries after the 1880s. While some have linked tariff protection to economic growth and development during this period (Bairoch, 1972; Clemens and Williamson, 2004; Jacks, 2006; Lehmann and O'Rourke, 2011; O'Rourke, 2000), others hold a more cautionary view arguing that this relationship is driven by sample selection and econometric specifications (Irwin, 2002; Schularick and Solomou, 2011; Tena-Junguito, 2009). Lampe and Sharp (2013) provide a synthesis of this alleged tariff-growth paradox, showing that while in some countries the correlation between tariffs and growth was positive, it was negative or non-existent in others. In contrast to previous studies that use aggregate data, this paper analyzes the impact of tariffs at the establishment level, documenting a sizable heterogeneity in the effects of tariffs on establishment-level development. In turn, I argue that such heterogeneity can contribute to the contradictory findings in the historic tariff-growth literature.

Sweden is a case in point for a potential tariff-growth paradox as it exhibited among the worldwide fastest growth rates during the late nineteenth century while simultaneously increasing tariffs (Schön, 2012, pp. 82, 123, 125, 136–137). This stood in sharp contrast to the previously pursued liberal policies with low industrial tariffs (Persarvet, 2019, p. 120). The

Swedish tariffs were first increased in 1888 to protect mainly agriculture and food products. They were later extended to also protect manufacturing in 1892 (Bohlin, 2005; Esaiasson, 1990; Lehmann and Volckart, 2011; Persarvet, 2019; Potrafke et al., 2020). Thus, if tariffs positively affected growth during this period, this should be especially evident in Sweden.

Previous research largely argued that these tariff increases were of little importance for Swedish economic development, however (Heckscher, 1941; Jörberg, 1965; Lampe and Sharp, 2013; Montgomery, 1947; Potrafke et al., 2020). While they deterred imports and led to some import substitution, they had little effect on increasing within-industry productivity or moving labor from agriculture to industry (Persarvet, 2019). However, as recent advances in trade theory show that tariffs have a heterogeneous impact across establishments (Chen and Steinwender, 2021; Iacovone, 2012; Melitz, 2003; Shu and Steinwender, 2019), there might be considerable establishment-level heterogeneity underlying these findings. I test this hypothesis in this paper.

Using industry-level tariff data from Persarvet (2019), I study the effect of Sweden's shift back into protectionism on establishment-level productivity. I do so by focusing on establishments active in 1891—i.e., the establishments that experienced the increase of industrial tariffs one year later—finding that, on average, the tariff increase did not affect establishment-level productivity. However, the tariff increases differently affected establishments conditional on their initial characteristics. Specifically, I distinguish between establishments that were initially more and less productive than their industry-level competitors. When doing so, I show that initially less-productive establishments arguably profited from tariff protection as they saw a relative increase in their productivity. However, initially more productive establishments saw a decline. Overall, a 1 percentage point increase in tariffs was associated with a 3 percent increase in productivity for the initially least productive establishments, whereas initially high-productivity establishments saw a relative decline of their productivity by 3 percent. For other establishments, the impact was in between these extremes.

Next, I show that this result is robust to a set of checks. Specifically, different splits of the sample and alterations of the econometric model produce similar estimates. I also show that the results remain robust when using the Arrelano-Bond estimator and an Oster bound analysis (Oster, 2019).

The observed patterns are consistent with two effects outlined in the recent trade literature (e.g. Shu and Steinwender, 2019). The *Schumpeterian effect* argues that increases in tariffs should increase the incentives for initially low-productivity establishments to innovate and learn to organize production efficiently since they now have the potential to capture a larger market share. In contrast, the *escape-competition effect* argues that the opposite effect holds for initially high-productivity establishments as they do not face international competition to the same extent anymore. While I cannot estimate the aggregate impact of tariffs, my results show that an increase in import tariffs helped in a relative sense one set of establishments but hurt others. In turn, this can explain why previous studies find, on average, no positive effect of tariffs on economic development in Sweden (and also

elsewhere). Establishment-level heterogeneity within and across countries is one explanation for the finding by Lampe and Sharp (2013) that the tariff-growth relationship differs across countries during the late nineteenth century. More broadly, this paper shows that institutional change intended to drive economic development can also have (potentially unintended) heterogeneous (and negative) consequences.

4.4 Local multipliers and the growth of services: evidence from late nineteenth century USA, Great Britain, and Sweden

Since the late nineteenth century is often seen as the industrial takeoff of the Swedish economy (Schön, 2012, pp. 82–84, 136–137), the first three papers of this thesis focus on the development of the Swedish manufacturing sector. As Figure 5 shows, however, also the service sector played an important role during this period. Indeed, while the historical origins of industry have been thoroughly studied, less focus has been devoted to the service sector (Broadberry et al., 2018). While it is generally argued that first industry and then services grew (Aghion et al., 2021; Kuznets, 1973), also across countries, the service sector was also historically important. For example, Great Britain, the birthplace of the Industrial Revolution, employed roughly 31 percent of its workforce in services in 1861, which rose by 10 percentage points until 1911. In contrast, industry grew at lower rates during this period (Lee, 1979, 1984). This paper broadens the analysis by (i) considering developments in the service sector and (ii) including countries other than Sweden in the analysis. Also, in a broader sense, while the first three papers take a supply perspective, this paper focuses more on the demand side of the economy.

Historically, the underlying drivers of the growth in services have been unclear. While some studies argue that industrial growth created income that could be spent on services (Crouzet, 1982; Mathias, 1969), others doubt that this mechanism can be generalized across countries (Lee, 1984). However, there are good grounds to suspect that industrial growth was one driver for the emergence of services. The employment multiplier framework developed in Moretti (2010) formally motivates that creating industrial jobs raises the aggregate income in cities, which leads through increased demand to an expansion of the local service sector. Moreover, these channels are of sizable effect as Moretti (2010) estimates that today 1.6 service jobs are created for each new industrial job in the USA. This effect is primarily driven by the creation of high-skilled industrial employment since it commands higher wages.

In my fourth paper, I analyze whether local employment multiplier effects can help explain the historical emergence of services. Specifically, I focus on the USA, Great Britain, and Sweden during the late nineteenth century, which is motivated by the different levels of economic development of these countries during this period (Broadberry et al., 2010). By applying a consistent methodology across these countries, I can estimate to what extent multiplier effects help explain the emergence of services. This stands in contrast to current

studies, which estimate multiplier effects for single countries (e.g., Moretti, 2010; Moretti and Thulin, 2013).

My analysis proceeds in two steps. First, I draw on full-count IPUMS census data (MPC, 2019; Ruggles et al., 2021) to reconstruct the sizes of the industrial and service sectors in local labor markets of each country. Second, I follow Moretti (2010) by using first-difference regressions and a Bartik shift-share instrumental variables strategy to estimate the employment multiplier across countries.

I find that across countries, about one local service job was created for each new industrial job. This multiplier was entirely driven by the creation of high-skilled industrial employment. In the USA, about 2.5 local service jobs were created for each high-skilled industrial job. The corresponding figure was lower in Sweden and Great Britain. Such dynamics are consistent with the USA having a more dynamic labor market during this period (Long and Ferrie, 2003). Crucially, I find that not just private services but also business—i.e., arguably more demanding—services expanded through multiplier effects. Overall, industrialization had more far-reaching implications than what is often recognized, as it propelled the development of other sectors, too.

5 Concluding Discussion

This thesis contributes to the question of why some countries are rich, while others remain poor. Today, a key barrier to economic growth and development in low-income countries is the persistence of small firms (Hsieh and Klenow, 2009, 2010; Schoar, 2010). Yet, also in modern high-income countries firms have generally been small prior to industrialization. Thus, an influential view maintains that countries only achieved sustained growth with the emergence of large-scale manufacturing firms (Chandler Jr., 1977, 1990; Kuznets, 1971). How these industrial establishments originally managed to grow (or why they potentially failed) has (largely due to data limitations) not been possible to quantitatively and consistently assess (Atack, 1985).

My thesis leverages newly digitized data covering in unique detail the performance of Swedish manufacturing establishments throughout the late nineteenth century. As the data are available on a yearly basis, I use automatic record linkage techniques to link them into a panel. In turn, this enables me to trace the establishments over time and account for establishment-specific idiosyncrasies in the empirical analysis. Thereby, I arguably come closer to a causal interpretation of my findings. In four papers, I show that—contrary to popular belief—Swedish manufacturing establishments generally remained small during industrialization. Thus, while aggregate growth rates document that Sweden (rapidly) industrialized during the late nineteenth century, I show how only a (relatively smaller) subset of establishments accounted for the major share of the country's industrialization process. While state intervention has often been highlighted as a critical factor for late-industrializing countries to achieve growth (Allen, 2011a, 2017), I find that it mainly contributed to the flourishing of marginal establishments. The passing of general incorporation

laws contributed to the diffusion of steam engines among small and rural establishments, whereas tariff policy increased the productivity of initially unproductive establishments. Yet, policy also had (potentially unintended) negative consequences as higher tariffs hurt establishments that were initially relatively more productive than their competitors. Once industrialization started, it led to further growth dynamics in services across countries. Specifically, I show how the expansion of manufacturing employment in the USA, Great Britain, and Sweden led to the creation of new jobs in the service sector.

This section ends this introductory chapter by providing a concluding discussion. It ties the findings of the papers together and puts them into a larger context, also showcasing their relevance for contemporary development policy. Relatedly, Section 1.3 expands on the contributions of this study, and Section 4 provides an executive summary of the respective papers.

At the aggregate level, Swedish economic development during the late nineteenth century has often been perceived as an industrial breakthrough (Schön, 2012, pp. 82–83). This is certainly an apt description, as Sweden, around 1900, was much more industrial and wealthy than it had been 50 years prior. Yet, against this backdrop, a common theme of my papers is that most industrial establishments remained surprisingly small and non-mechanized during Sweden's industrialization. Consequently, relatively fewer establishments accounted for the largest parts of its industrial breakthrough. Notably, this persistence of small non-mechanized establishments throughout industrialization is not a feature unique to Sweden as it is observed in other contexts, such as the USA, as well (Atack, 1985, 1986, 1987; James, 1983; Ziebarth, 2013). Moreover, this finding somewhat resembles processes of industrialization in today's low-income economies. While some competitive manufacturing firms emerge in such countries, the industrial sector often remains too small to noticeably affect aggregate development (Rodrik, 2013). In contrast, the Swedish case is remarkable as here (a subset of) establishments managed to grow large and drive industrialization. Consequently, this thesis shows several channels through which establishments achieved growth.

How did Swedish establishments manage to grow? My thesis focuses on the Second Industrial Revolution, where previous research attributes an important role to the state in spreading industrialization across countries. Selected policies have traditionally been highlighted as drivers of the industrialization process—e.g., the liberalization of markets or tariff policy—which the Swedish and other states followed (Allen, 2011a, 2017). Consequently, I analyze the impact of such policies on establishment-level development. A broad takeaway from my thesis is that state policy was successful as it allowed especially marginal establishments to expand, grow, and adopt new technologies. On this account, the state set (arguably the *right*) incentives, and establishments reacted and grew. Yet, Paper III also comes with a word of warning against (potentially unintended) side effects of industrial policy. Since establishments are heterogeneous, legislation can differentially incentivize them, which in turn has the potential to lead to negative outcomes. Moreover, in this paper, I have not focused on the long-run consequences of tariff policy, which future research might

very well determine to be negative. As such, the thesis shows that designing a successful industrial policy is not straightforward.

Similarly, other channels than the ones analyzed in this thesis exist through which establishments can grow large, and future research can determine their relative role in explaining (Swedish) economic growth. For example, declining transport costs through the installation of railways has been highlighted as one factor to promote establishment-level growth (Atack, 1985, 1987; Rodrik, 2013; Ziebarth, 2013). While the installation of railroads was at the heart of Swedish economic growth (Andersson et al., 2023; Berger, 2019b; Berger and Enflo, 2017), analyzing to which extent it enabled establishments to grow their markets remains for future research.

Ultimately, the findings in this thesis show that there is tension when countries undergo industrialization as small establishments continue to coexist next to large ones. As such, one can wonder whether (Swedish) industrialization was a fast process that could—under different circumstances—have proceeded even faster. Overall, the finding of small and large establishments coexisting resonates with a revisionist literature that stresses that Swedish growth during the late nineteenth century was slower than previously thought but started from a higher level (Edvinsson, 2013; Hamark and Prado, 2022). Consequently, this explanation emphasizes that the late nineteenth century presented a more continuous and not radically different growth process relative to the prior decades. Yet, the growth of (a subset of) establishments seemingly enabled Sweden to converge with the leading economies of its time within just 50 years. In contrast, many low-income countries remain economically behind until today (Figure 1). This is a remarkable achievement. Moreover, Sweden followed the leading industrial policies of its time and had to cope with geographically dispersed markets. As such, it is difficult to imagine that Swedish industrialization could have proceeded even faster. On the downside, this implies that also today, it will take time for countries to achieve economic development. But on the upside, this thesis shows several channels through which this can (or should not) be achieved.

While a central theme of this thesis is to show how some establishments managed to grow large, it is important not to interpret this as an argument for *big business* or against the importance of young, dynamic, and small firms for economic development. While start-ups are crucial today for American economic growth (Haltiwanger et al., 2013), it is important to highlight that such start-ups are qualitatively different from the ones in low-income countries. Most importantly, start-ups in the USA exhibit after their founding an *up or out dynamic*, whereas young and unproductive firms survive relatively longer in low-income countries (Eslava et al., 2019). Before industrialization, the large firms characteristic of today's high-income economies did not exist (Chandler Jr., 1977, 1990), so this thesis can be seen as an attempt to understand how some establishments—initially resembling today's successful start-up companies—managed to start growing.

With its main interest in establishment-level growth, this thesis focuses to a lesser extent on other consequences of the industrialization process. As such, it has to leave some highly interesting questions unanswered. For example, the expansion of the factory sys-

tem and technological change had important labor-market consequences, especially on the employment of women (and children). A debated question is to what extent women benefited from industrialization (Merouani and Perrin, 2022), and—while this is not done in this thesis—my data have the potential to significantly contribute to such discussions. Traditionally, it is emphasized that the participation of women in the labor force exhibited a U-shaped development as it declined with industrialization but later increased (Goldin, 1994; Merouani and Perrin, 2022). A separation between the domestic and public spheres also occurred in late nineteenth-century Sweden, whereby men increasingly worked in factories and women in the household (Stanfors and Goldscheider, 2017). Relatedly, a key question with contemporary relevance is to what extent new technologies, such as the steam engine, replaced (unskilled) labor or augmented it during industrialization (Acemoglu and Restrepo, 2018; Atack et al., 2019; Autor and Salomons, 2018; Frey, 2019; Heikkuri et al., 2022; Ridolfi et al., 2022). Newer contributions highlight that the diffusion of steam power was not necessarily deskilling and larger establishments relied on (cheaper) female labor to a larger extent (de Pleijt et al., 2020; Heikkuri et al., 2022; Ridolfi et al., 2022). Our results in Paper I are in accordance with such findings, as having a relatively feminized workforce is only associated with establishment-level survival through its positive effect on establishment-level size. Yet, formally modeling the gendered impact of technological and organizational change using our Swedish establishment-level data remains an avenue for further important research.

Arguably, this thesis mainly focuses on how supply-side factors can successfully enable establishments to grow, although the last paper extensively focuses on the demand side. While a focus on the supply side is not seen as a downside, it is worth emphasizing that explanations focusing on the demand side also provide fruitful avenues to explain how establishments grew large during industrialization. For example, Syverson (2004a) and Syverson (2004b) show how thicker markets enable consumers to more easily switch between products, which ultimately leads to the disappearance of less-efficient producers. While I show how incorporation contributed to the diffusion of steam technology, another alleged benefit of the corporate form is that it enabled establishments to distribute and market their products more widely (Chandler Jr., 1977, 1990). Using our establishment-level data, future research can examine whether such channels help explain (Swedish) industrialization and how they potentially interacted with the installation of, for example, railways.

As Sweden became one of the leading industrial countries within only a few decades during the nineteenth century, it begs the question of whether the Swedish experience—and by extension, the underlying drivers identified in this thesis—can be extended to other countries and modern contexts, where many economies remain poor (Figure 1). In principle, this seems possible. A key insight of this thesis is that (arguably relatively) simple policy changes allowed for widespread industrialization since marginal establishments flourished. For example, the ability to incorporate mattered for technological diffusion and economic growth. As such, my findings contrast, for example, patterns observed in Imperial Russia, where incorporation remained costly, which arguably delayed widespread industrialization

(Gregg and Nafziger, 2019, 2020). Similarly, tariff policy seemingly helped initially low-productivity establishments relative to initially high-productivity establishments in becoming more productive. There are rather positive findings for modern development policy, as they imply that policy changes—even in the absence of large investments as, for example, the installation of railroads is quite expensive—can successfully promote industrialization. In that sense, the Swedish experience might serve as a positive example for (today's) industrializing countries to emulate.

Yet, while such drivers of growth prima facie should also be relevant in other contexts, it is unlikely that simply copying (the Swedish) policies will automatically lead to economic growth. Sweden's industrialization occurred after a period of agricultural transformation and was built on a relatively well-educated workforce. Being an impoverished sophisticate (Sandberg, 1979) meant that laws were not only formally put in place but also actively enforced. Ultimately, such background conditions and broader social capabilities (Abramovitz, 1986)—e.g., a functioning public administration, social trust, a literate and educated workforce, and shared values—matter for industrial policy to work. Indeed, for such reasons, economists generally started to reject the implementation of industrial policies during the second half of the twentieth century, which generally did not increase the growth of low-income countries (Irwin, 2021). In practice, such industrial policies increasingly favored large domestic firms that lobbied for more protectionism, which decreased competition, innovation, and technological dynamism (Aghion et al., 2021, pp. 67–68). Relatedly, there is evidence that social trust becomes increasingly important in driving firm formation as the level of economic development decreases (Corradini, 2022). As such, it is not only the availability but also the (credible) enforcement of rules and laws that enables, for example, the corporate form to drive economic growth successfully. Therefore, another area for further research is to assess how the broader Swedish institutional landscape interacted with establishment-level growth dynamics. Yet, even if a single policy from the Swedish context will unlikely automatically be a driver of growth in other contexts, this is not a lost cause. As development policy is and must be context-dependent, the insights of this thesis contribute to the joint stock of knowledge based on which development policies can be conceived (Koyama and Rubin, 2022, p. 224).

Indeed, there is evidence that low-income countries today have an increasingly more challenging time industrializing than countries in the nineteenth century. A key challenge for today's low-income countries is that they often experience *premature deindustrialization*. As Asian—and especially Chinese—manufacturers gain in competitiveness, the relative economic importance of manufacturing in African and Latin American economies declines both earlier and at lower levels compared to the historical experience of today's high-income countries (Rodrik, 2016). Arguably, as Paper IV shows, this can also negatively impact the local service sector. As such, premature deindustrialization presents a threat to the economic development of low-income countries. Yet, the insights from this thesis show how it is possible to—if not avoid—at least delay premature deindustrialization. For example, the thesis shows how the ability to incorporate created broader growth processes

within the Swedish institutional framework. This contrasts, for example, the Imperial Russian experience where connections between firms and politicians arguably increased factor misallocation in industry and thus delayed industrialization (Gregg and Nafziger, 2020).

A related question is whether today's low-income countries need to industrialize at all to catch up economically, as arguably more development strategies are available for them to choose from. As such, it has recently been highlighted that services are becoming increasingly tradable, and the welfare of workers can be improved by posting them to other countries where they temporarily perform certain services (Jensen et al., 2005; Muñoz, 2022). Alternatively, services can also be outsourced to low-income countries (Rodrik, 2016). Moreover, the example of India suggests that the development of a service sector alone can contribute to economic growth (Aghion et al., 2021, pp. 169–172). As such, it could be argued that developing a manufacturing sector should not be (anymore) the top priority of governments of low-income countries.

My results speak against such arguments. From a long-run perspective, developing a manufacturing sector was crucial for countries to experience economic growth (Amsden, 2001, pp. 1–2). For Sweden, I show how (some) establishments managed to grow and exhibit technological dynamism, which absorbed (unskilled) workers echoing arguments proposed by Rodrik (2016). In a second step, I show how this expansion of industrial growth drove the emergence of—notably also skilled—services. As such, an industrialization-led strategy enables broader processes of economic growth that benefit larger parts of the workforce. Therefore, this thesis takes a cautious stance against service-led growth strategies.

Generally, by analyzing how Sweden industrialized and raised its living standards, this book tells a (largely) positive story. Yet, there are also potentially negative aspects connected to economic growth, which warrant a discussion. Currently, (man-made) climate change poses a significant risk to the survival of our very own species. If economic growth ultimately entails the destruction of the very environment in which we live, one has every reason to be skeptical about its usefulness. Yet, there is no reason to despair, as modern economic growth can also be the key to overcoming environmental challenges. As countries grew richer, they managed, in the long run, to reduce their emission levels through, for example, technological progress and innovation (Kander, 2002; Kander et al., 2013; Koyama and Rubin, 2022). Moreover, as services may be more environmentally friendly (Aghion et al., 2021, p. 172), industrialization may indirectly contribute to the protection of the environment through the employment multiplier effect. Relatedly, this thesis also shows how establishments become more efficient through innovation and can be encouraged to adopt new technologies. Such processes are at the heart of modern economic growth and will undoubtedly be needed when tackling contemporary challenges.

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Appendix

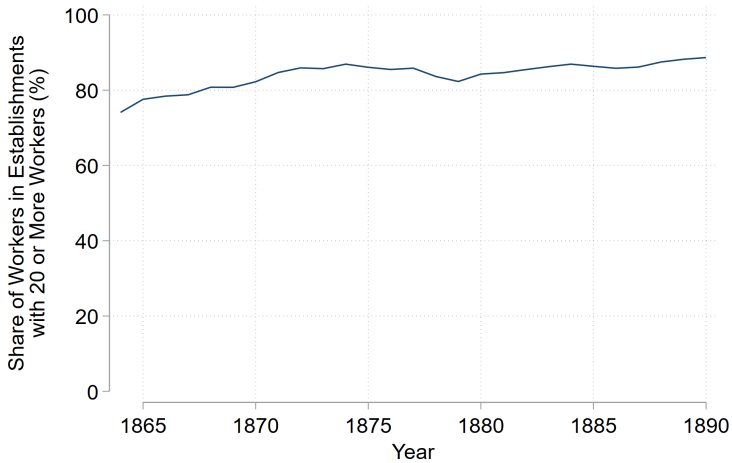


Figure A.1: Share of workers employed in large establishments
Source: Fabriksberättelserna.
Notes: The figure shows the share of workers employed in large establishments per year. Large establishments are defined as establishments with 20 or more workers.

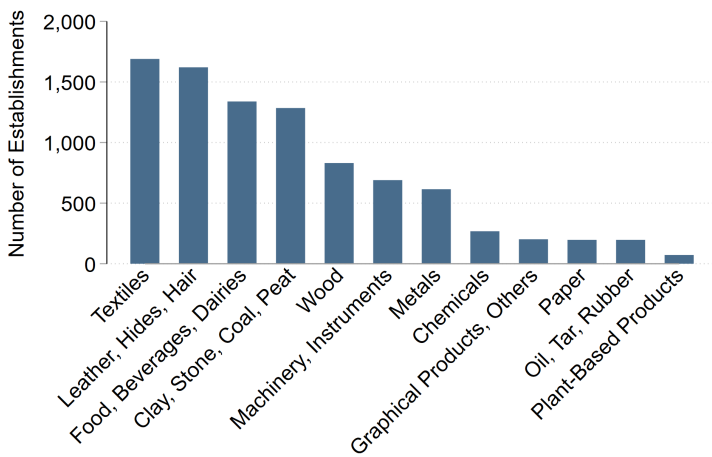


Figure A.2: Number of establishments per industry
Source: Fabriksberättelserna.
Notes: Own calculation and representation.

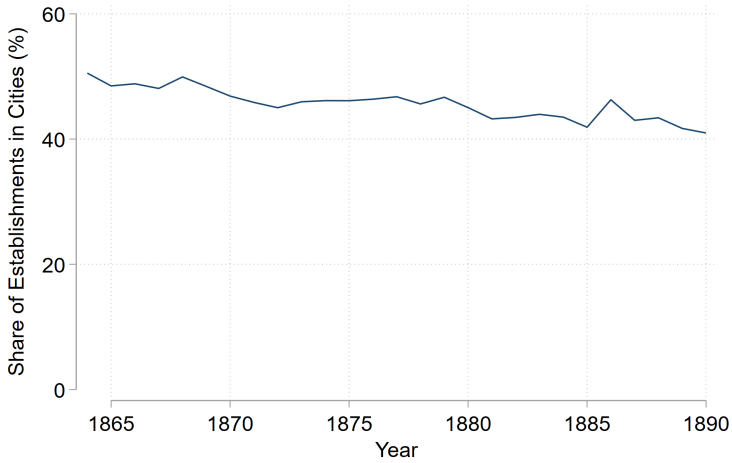


Figure A.3: Share of establishments located in cities
Source: Fabriksberättelserna.
Notes: The figure shows the share of establishments that are located in cities. Cities and rural areas are defined according to the raw data, which were collected in separate books for each type of area, respectively, by the enumerators.

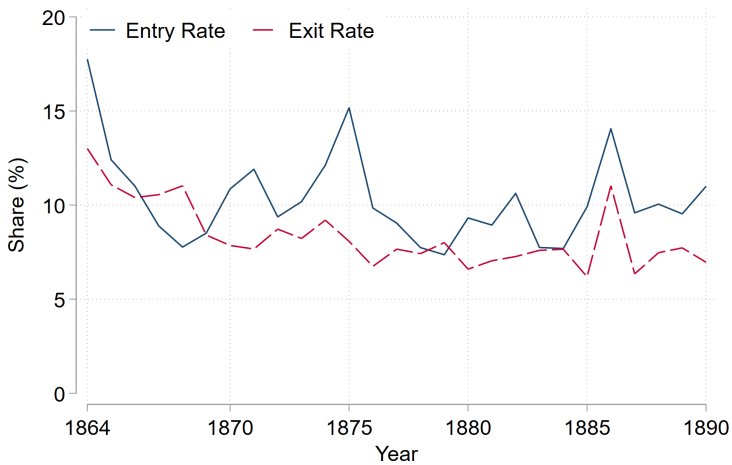


Figure A.4: Entry and exit rates
Source: Fabriksberättelserna.
Notes: The entry and exit rates are calculated as the share of establishments that enter/exit among all active establishments in a given year.

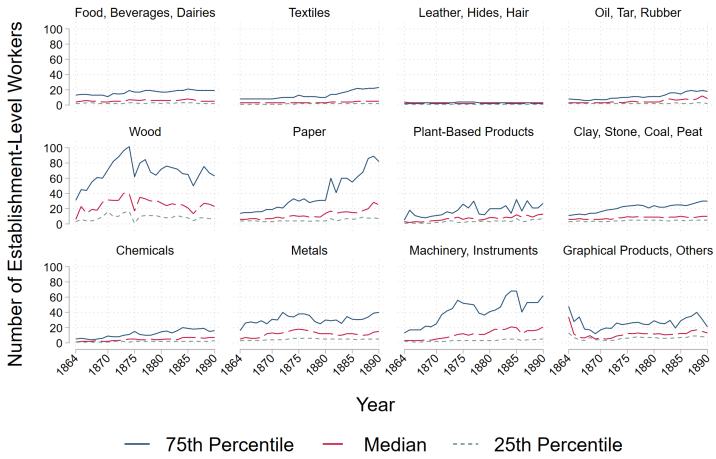


Figure A.5: The evolution of establishment-level size by industry
Source: Fabriksberättelserna.
Notes: The figure displays the evolution of establishment-level size by industry using the number of workers as a proxy. For example, the figure shows how many workers the median establishment employed in a given year.

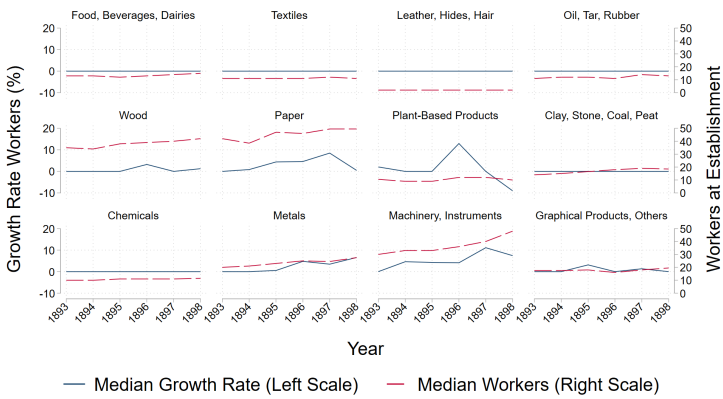
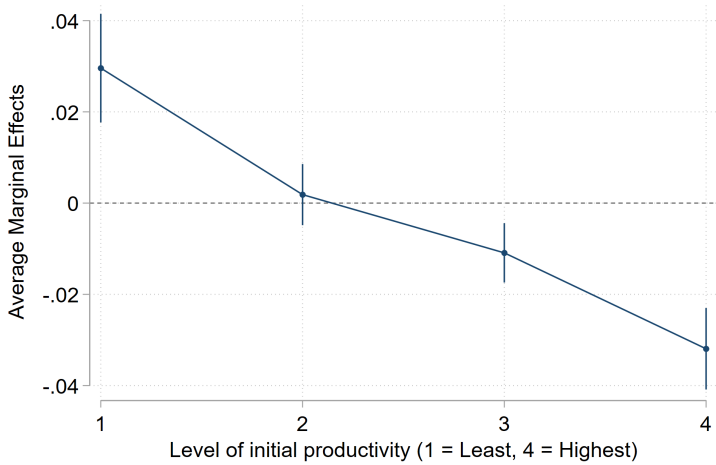
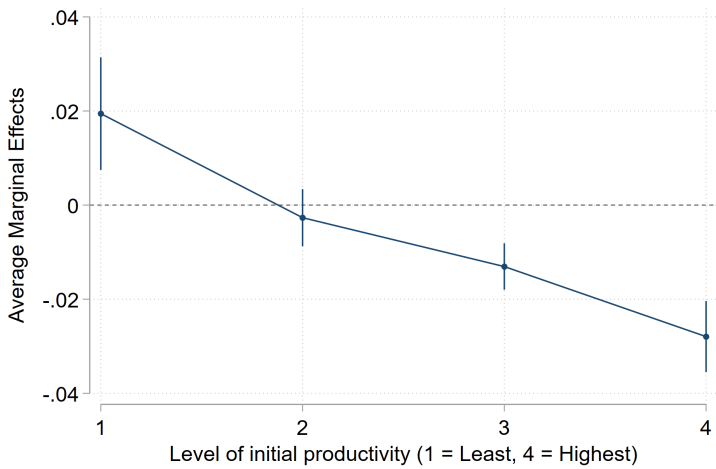


Figure A.6: Establishment-level workers by industry and year
Source: Fabriksberättelserna.
Notes: The figure shows the median establishment-level growth rate of workers compared to the previous year (left scale) and the median establishment-level number of workers (right scale) per year and industry. The figure excludes observations where the total number of establishment-level workers is zero or not reported and includes only observations for establishments that are observed in all years between 1892 and 1898.



(a) All years



(b) 1891-1895

Figure A.7: Average marginal effects of tariffs on establishment-level productivity
Source: Fabriksberättelserna and Persarvet (2019).
Notes: (a) The figure replicates Figure 4 from Paper III. (b) The figure is the same as Figure (a) but includes only information for the years 1891 to 1895. See the notes to Figure 4 from Paper III for more details on the specification.

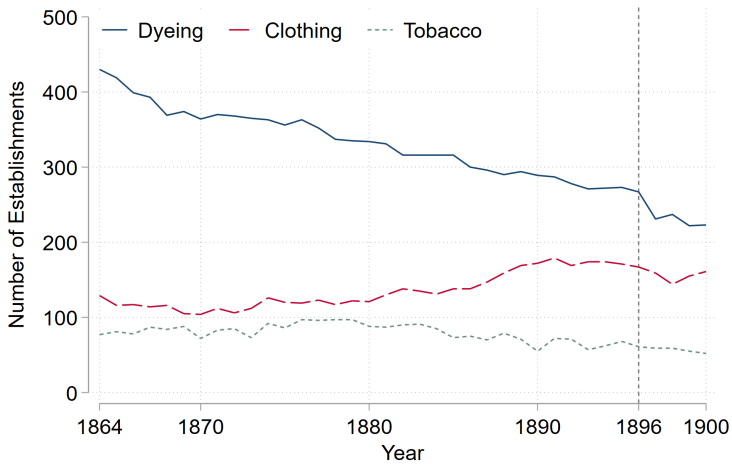


Figure A.8: Number of observations for selected subindustries
Source: Fabriksberättelserna.
Notes: The figure shows the number of dyeing, clothing, and tobacco establishments over time. According to Kommerskollegii (1864), 425/129/90 dyeing (färgerier)/clothing (klädesfabriker)/tobacco (tobaksfabriker) establishments existed in Sweden in 1864. In the same year, I find in my data 430/129/77 establishments, respectively, when searching for the terms *färger*, *klädes* or *spinneri*, and *tobak* within the strings describing the industry an establishment was active in. Here, I do not drop observations where no workers are reported.

Table A.5: The multiplier effect of tradable employment on non-tradable employment in levels

	USA		Great Britain		Sweden	
	(1) FE	(2) IV	(3) FE	(4) IV	(5) FE	(6) IV
Workers in Tradable Sector	2.121***	2.345***	0.730***	0.846***	1.238***	1.498***
	(0.192)	(0.080)	(0.009)	(0.166)	(0.247)	(0.217)
Number of Observations	488	488	88	88	252	252
Number of Districts	488	488	30	30	84	84
Within R-Squared	0.909		0.932		0.779	
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Unit FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic First-Stage		45		5		72

Notes: The dependent variable is the number of workers in the non-tradable sector. Cluster-robust standard errors at the district-level are given in parentheses. The table shows the Kleibergen-Paap rk Wald F-statistic. The levels of significance are *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A.6: The multiplier effect of tradable employment on non-tradable employment for different regional aggregations

	Sweden - 4-Digit		Sweden - 2-Digit	
	(1) FE	(2) IV	(3) FE	(4) IV
ln Workers in Tradable Sector	0.663***	1.022***	0.694***	2.190*
	(0.091)	(0.151)	(0.121)	(1.155)
Number of Observations	252	252	72	72
Number of Districts	84	84	24	24
Within R-Squared	0.287		0.382	
Jobs Created	0.508	0.782	0.531	1.676
Time FE	Yes	Yes	Yes	Yes
F-Statistic First-Stage		27		2

Notes: The dependent variable is the number of workers in the non-tradable sector in ln. Cluster-robust standard errors at the district-level are given in parentheses. In all regressions I take the ratio of non-tradable to tradable workers as stated in Table A.4. The table shows the Kleibergen-Paap rk Wald F-statistic. The levels of significance are *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table A.7: Using different definitions of the tradable and non-tradable sector

	USA				Great Britain				Sweden			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	A	B	C	D	A	B	C	D	A	B	C	D
ln Workers in Tradable Sector	0.751***	0.640***	0.851***	0.652***	0.787***	0.588***	0.830***	0.588***	0.663***	0.129***	0.670***	0.110***
	(0.047)	(0.048)	(0.039)	(0.046)	(0.071)	(0.084)	(0.060)	(0.085)	(0.091)	(0.036)	(0.083)	(0.033)
Number of Observations	488	488	488	488	88	88	88	88	252	252	252	252
Number of Districts	488	488	488	488	30	30	30	30	84	84	84	84
Within R-Squared	0.588	0.487	0.704	0.521	0.696	0.573	0.809	0.568	0.287	0.051	0.259	0.076
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the number of workers in the non-tradable sector in ln. Cluster-robust standard errors at the district-level are given in parentheses. In specification A, I use the main definition of the tradable and non-tradable sector. In specification B, I exclude occupations that could be both tradable and non-tradable. In specification C, I include occupations that could be tradable in the tradable sector and use as outcome only occupations that are clearly non-tradable. In specification D, I include occupations that could be non-tradable in the non-tradable sector and use only clearly tradable occupations as independent variable. The levels of significance are *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

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Why Firms Grow

The Roles of Institutions, Trade, and Technology during Swedish Industrialization

Industrialization and the emergence of a manufacturing sector are generally perceived as key drivers for countries to see economic growth and increases in living standards. Only 200 years ago, most countries were relatively poor and had similarly low living standards. With industrialization and the growth of manufacturing, primarily Western countries pulled ahead and noticed sustained increases in living standards. Eventually, this process led to a divergence in economic performance. While today high-income economies are characterized by relatively larger firms that use novel production techniques based on the latest scientific advances, firms in low-income countries generally remain small and are less efficient.

How did today's high-income countries initially manage to start growing and industrializing? While existing explanations focus on the roles of, for example, institutions, trade, and technology, such aspects have generally not been analyzed at the level where economic growth occurred: the industrial firm. Consequently, understanding how (Western) firms managed to increase in size and productivity may also inform current debates.

This thesis analyzes the causes of industrialization at the firm level. It studies how (some) manufacturing establishments managed to start growing, adopted new technologies, and learned to organize themselves more efficiently in late nineteenth-century Sweden. As such, the thesis focuses on the formative years of the Swedish economy when the country developed from being one of the poorest on Europe's periphery into one of the fastest-growing economies worldwide. To do so, the study leverages newly digitized data that cover in unique detail the yearly performance of Swedish manufacturing firms.

In four papers, the thesis shows how policies that generally have been perceived as key drivers of the industrialization process—e.g., general incorporation laws or tariff protection—enabled marginal establishments to grow, organize as factories, and adopt new technologies, such as steam power. Yet, state policy was no panacea as it (sometimes) negatively affected leading establishments. Using individual census data on the employment of individuals in Sweden, the USA, and Great Britain, the study also documents how industrialization led to further growth dynamics, primarily in the service sector. More broadly, this thesis shows how firm-level growth in manufacturing created an economic dynamism that would ultimately better the lives of people.

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