A Winning Strategy? The employment of women and firm longevity during industrialization

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The employment of women and firm longevity during industrialization

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Abstract

Why do certain firms prosper and grow old while other firms fail? Established knowledge tells us that it is related to the firm's ability to adapt to market conditions, for example through product diversification, learning-by-doing, and through the adoption of new strategies regarding technology, human resources, and management practices. This paper argues that the employment of women constituted an important competitive advantage for firms in nineteenth-century manufacturing. By using new data covering the entire Swedish tobacco industry, estimating duration models, we find that firms which employed more women were considerably less likely to fail than firms which employed men. The strategy of hiring women in order to reduce costs was a winning strategy among firms in a labor-intensive industry in competitive markets. Thus the adopters of this strategy lived on. The extended longevity of more feminized firms, in turn, reshaped the whole industry. Industry feminization may thus be seen as result of a competitive process in which more feminized firms through longevity came to dominate the industry.

JEL classifications: L10, L66, C41

Key words: Firm survival, longevity, competing risks, competition, female employment

Introduction

The question of why some firms survive and grow old while others fail has attracted attention from scholars in various disciplines. Many efforts have been made to describe and explain firm survival and industry dynamics from an economics perspective (e.g., Dunne, Roberts and Samuelson, 1988; Klepper and Simons, 1997, 2000; Agarwal and Gort, 2002; Klepper and Thompson, 2006). Business history literature is replete with examples of companies, which, to varying degrees, failed or succeeded in adapting to a shock or to an evolving environment, especially technological change and market competition (see Jones and Zeitlin, 2007: parts I-II) that threatened their survival. The fact that some companies managed to survive and even prosper despite change in their environment leads us to the fundamental question: What differentiates the companies that successfully adapt to change from those that do not? This article provides an answer to this question while contributing to the literature on firm survival and deepening the understanding of firm longevity in an historical context. Using unique data comprising all the firms operating in the Swedish tobacco industry in the second half of the nineteenth century, we focus on how the employment of one particular input – women's labour – affected firm longevity. The evidence presented in this paper shows that firms which employed more women than their competitors faced a significantly lower risk of failure, and thus they lived on and came to dominate the industry.

Firm longevity poses a complex challenge to the historian. On the one hand, old firms differ from young by having acquired experience and productive resources. On the other hand, firms survive and grow old because they are or were fundamentally different from firms that fail. A long tradition exists in business history of addressing these critical issues through case studies describing how firms stay competitive given a specific context (e.g., Nenadic, 1993; McGovern, 2007; Kipping and Cailluet, 2010). This paper remains true to this tradition by studying firms in a specific historical setting but departs from the standard case study approach by considering a particular industry as a whole. While precluding us from considering the most intimate inner workings of firms provided by case studies, our approach has a number of advantages given the topic at hand. First, we avoid any survivorship bias, since the many firms that failed are as much part of our story as the ones that thrived and grew old. Second, our approach allows us to explicitly model longevity and statistically assess the relative importance of firm characteristics for survival. Third, by considering a complete industry population of firms, we can explore the wider implications of firm longevity on an

industry and society at large. In the long run, given an efficient market, under-performing firms will fail and competitive firms survive. If the cause of survival and subsequent longevity among firms can be found in a set of specific capabilities, the characteristics of successful firms will, through natural selection, eventually come to typify the industry as a whole. By exploring and testing how one such characteristic, female employment, affected firm survival, we show how the longevity of the firms that employed more women shaped the whole industry by gradually transforming its workforce from a male- to female-dominated one over a fifty-year period.

In the remainder of this paper, the viability of the employment of women as a winning strategy is discussed and tested by statistical modelling of firm longevity using proportional hazard models. Our case is tobacco manufacturing in nineteenth-century Sweden. For this industry we have collected very rich data covering all firms that were active between 1863 and 1885. We follow firms until 1915, the year in which the industry nationalized.

Firm longevity and female employment as a competitive advantage

Firm longevity may be considered from two perspectives. Firstly, age has implications for performance and viability. With age, firms acquire knowledge and capital that make them less vulnerable. Jovanovic (1982) explains the dependence between age and survival as the result of a passive learning regime in which a firm's true capabilities, while initially unknown, are discovered over the time it spends in the market. Once the firm is better informed about its capabilities, decisions as to whether or not it should exit the market are taken. The prediction is that a few exits will take place soon after establishment, followed by early exits of less capable firms and the continuation of more competitive firms. Learning also lies at the heart of the model proposed by Ericson and Pakes (1995) in which firms actively learn by doing and invest accordingly in order to remain viable. This results in high failure rates during the initial learning phase with improved survival prospects in later periods as a result of resource accumulation. Secondly, firm longevity is in itself an outcome. As argued by Friedman (1953) survival and longevity in a competitive market setting results from a process favouring efficient and profitable firms. Being efficient and profitable does in this case not necessarily imply that firms are profit maximizing (Alchian, 1950). Indeed, not even the most competitive firms are required to be profit maximizers. Rather, what matters for survival and longevity is a firm's efficiency and profitability relative to its competitors.

For most firms, wages constitute a major share of costs, making hiring and retaining staff important managerial decisions (Wright, McMahan and McWilliams, 1994; Becker and Gerhart, 1996; cf. Gospel, 2007). When choosing whom to hire, employers care primarily about the productivity of workers and their associated wages, and seek employees who offer the best combinations of productivity and costs. If men's higher wages relative to women's are not entirely motivated by productivity differences, men's labour is more expensive than women's. Hence, if women can be employed doing the same job as men but at a lower cost, then hiring women will be an efficient strategy and constitute a competitive advantage for firms adopting this strategy. But given that one labor input is relatively less expensive than another, why do not all firms choose to hire the cheaper input?

One answer to this question is provided by Becker's (1957) seminal model in which an employer who refuses to hire an employee with a productivity that equals or exceeds his/her cost is presumed to reveal discriminatory preferences (own, those of workers and/or customers). Discriminating firms will therefore, all else held constant, face higher unit costs of production than their competitors and will be likely to find their long-term position in the market untenable and are therefore expected to exit the industry.

Throughout history women have always earned less than men. To what extent the difference between men's and women's earnings can be explained by productivity differences or discrimination is highly dependent on period and context. During the nineteenth century, earnings were often gender-neutral since work was simple, individual productivity easily measured, and piece rates were widely used (Cox and Nye, 1989; Goldin, 1990; Burnette, 2008). Workers in the nineteenth-century Swedish tobacco industry were paid either by the piece or hour. While piece rates were gender-neutral, hourly wages were not, providing an exploitable opportunity for firms to employ women instead of men and cut costs (Stanfors *et al*., 2013).

A large body of anecdotal evidence supports the idea that nineteenth-century firms sought to employ women in place of men to increase competitiveness. In the late nineteenth-century English hosiery industry it was seen to benefit employers' if they hired women in place of men as long as women could be paid less for the same amount and quality of work, and this resulted in employers attempting to hire women workers in place of men (Rose, 1987: 170-

171). The process of substituting women for men was, however, not limited to hosiery factories, but common in several manufacturing industries. In both umbrella making and the manufacturing of tins for preserved food, lower-paid women were replacing higher-paid men (Webb, 1891: 647-648). In Glasgow in 1833, the managers of a cotton mill decided to hire women mule spinners "in the expectation that they [the company] would be able to reduce their wages lower than the rates paid to male spinners" (British Parliamentary Papers, 1833, *The First Report of the Central Board*, (XX), 84-85, quoted in Valverde, 1988: 623). Moreover, Anthony Austin, reporting to the Handloom Weavers Commission, concluded that in South West England "women are employed, who will readily undertake it, at a lower wage than men receive [...]. By this process (unless the men consent to take the lower rate of wage) the whole of the weaving is gradually put into the hands of women [...] and the men are compelled to seek other work" (British Parliamentary Papers, 1840, *Handloom Weavers Commission* (XXIII) 282, quoted in Burnette, 1997). Historical accounts clearly show that nineteenth-century firms were actively adapting their workforce by hiring women instead of men in jobs where both genders were equally useful and productive, as a way to reduce costs and thereby increase competiveness.

In a modern setting, the employment of women has been shown to affect both the profitability and survival of firms. Hellerstein, Neumark and Troske (2002) find that firms which employ a high share of women, and have some market power, are more profitable. For start-up firms, which by nature are predominantly small and inexperienced, and therefore more sensitive to managerial decisions, personnel policies are especially critical. Firms that choose to hire more women in the start-up phase are subsequently rewarded by a lower risk of failure (Weber and Zulehner, 2010). First hires are likely to be responsible for important management decisions during start-up and in later periods, thus highlighting the role of gender diversity among firm management (Weber and Zulehner, 2009). The effect of the gender composition of the workforce is, however, complicated by crowding and segregation. Highly segregated firms (measured by having either a strongly male-dominated or female-dominated workforce) perform significantly worse compared to firms with a more gender-balanced workforce (Persson and Sjögren Lindquist, 2010).

The incentives for employing women and the impacts thereof are, however, not independent of the market but affected by the level of competition. This is exemplified by Ashenfelter and Hannan (1986) who show that when markets are more competitive, firms are forced to act

rationally and change their hiring practices accordingly (that is, in a less discriminating manner). The impetus to hire more women may also come from within the firm as the result of a change of management. By modeling changes in workforce composition following takeovers, Heyman, Svaleryd and Vlachos (2013) find that firms that operate in weakly competitive markets (in which the pressure to minimize costs was less prior to the takeover) increase their share of female employees under new ownership.

While the economic decision made by a firm to employ women instead of men is based on preferences, productivity and wages, this choice is affected by conditions which can either accelerate or constrain the process. An employer who chooses to employ women in order to cut costs feels pressure , on the one hand, from the level of competition in the market while being simultaneously forced, on the other hand, to contend with norms and practices governing the recruitment of labour imposed by society at large (Stinchcombe, 1965). In this context female employment may be considered one form of cost-cutting process innovation (cf. Klepper, 1996; Cefis and Marsili, 2005). That improvements in processes, such as the employment of a particular group of workers, would prove decisive is very plausible given that the firms in our study were part of a well-established and mature industry experiencing little technological progress, few product innovations, competition in labour and product markets, and a work process allowing both men and women to perform most jobs.

The Swedish tobacco industry, 1863–1915

Tobacco manufacturing in nineteenth-century Sweden encompassed a simple non-mechanized work process organized in both small workshops and large factories housing hundreds of workers. Even by 1897, the manufacturing process was considered to be identical to the crafts industry despite being factory-based. In this regard the industry shared similarities with textile manufacturing, which also featured elements of both old-style artisanal and modern factory production (Gospel, 2007). At the beginning of the nineteenth century snuff, chewing tobacco and smoking tobacco dominated output, while cigars became increasingly popular after 1850 (Kommerskollegii, 1863–1910). Cigars were rolled by hand (sometimes using simple wooden implements) while snuff, chewing tobacco and smoking tobacco were shredded using mills that were often man-powered, but in some cases powered by water, animals or steam. Although the first cigarette machine was patented in the US in 1881 (Bonsack, 1881), it was not until after the industry's nationalization in 1915 that mechanization led to a rationalization

and transformation of the Swedish tobacco industry.[1] Since mechanization and returns to scale were not decisive factors in production, entry into the industry did not require large initial capital outlays on specialized machinery, making sunk costs very low.

In 1863, the year in which the Swedish Board of Commerce first recorded separately the employment of men and women in manufacturing, only 21 percent of the employees in the tobacco industry were women. Half a century later, on the eve of the industry's eventual nationalization in 1915, women had come to dominate the workforce (see Figure 1). While the feminization that took place was in a fairly persistent, industry growth was more erratic; the industry experienced periods of expansion in the late 1860s and early 1870s, and from the mid-1880s until the years prior to nationalization.

Figure 1 about here

While the overall output of the Swedish tobacco industry increased during the second half of the nineteenth century, the number of active firms remained around 100 in each year throughout the period, in each year, new entrants replaced exiting firms. The industry's rates of entry and exit (on average 8 and 7.5 percent, respectively) are in line with modern rates which typically range between 5 and 15 percent (Dunne, Roberts and Samuelson, 1988, 1989; Caves, 1998; Bartelsman, Scarpetta and Schivardi, 2005; Lotti, 2007). The industry was thus not subject to a "shake-out" followed by a concentration of production in a handful of firms, as happened in the American car industry prior to the Second World War (Geroski and Mazzucato, 2001; Klepper, 2002), and nor did the growth in output lead to an increase in the number of firms, as happened in the case of the nineteenth-century American shipbuilding industry (Thompson, 2005).

Turning to labour market conditions, the late nineteenth-century labour market for tobacco workers is a good example of the liberal labour market regime which dominated the period after 1850. It is best described as lightly regulated by both modern and historical standards. Apart from restrictions on the use of child labour, firms were free to hire as they pleased, and they were free to hire and fire as they pleased; no minimum wage existed, and there were no regulations prohibiting the employment of women and no requirements regarding formal qualifications or guild membership. Swedish tobacco workers were unionized in 1889 but, unlike its American equivalent, the *Swedish Tobacco Workers' Union* admitted women as

members and was not opposed to their employment (Lindbom and Kuhm, 1940; Cooper, 1987).

The market for tobacco products was characterized by a competitive environment driven by a large number of firms producing relatively cheap, homogenous, and easily transportable products that were predominantly manufactured from the same imported tobacco. Although the market was mainly domestic, firms, in addition to competition from rivals in the domestic market, and despite the existence of tariffs on manufactured tobacco products, also had to contend with competition from imported tobacco goods (Kommerskollegii, 1863–1885).

The beginning of our period of study coincides with the introduction of the Freedom of Trade Act in Sweden. Enacted in 1864, this reform effectively lowered the legal barriers to entry by removing several previous requirements. Prior to 1864, in order to start a business, the principal had to have prior experience of the trade in question, be literate, considered a person "of good standing", and, if business were to be conducted in a city or within a five kilometers thereof, burghership was required. After its enactment, citizens were free to start an enterprise as long as they were of full legal age and registered the business with the relevant authority (Rabenius, 1888). Our study ends with the nationalization of the tobacco industry in 1915. The decision by the state to nationalize the tobacco industry was driven by a need to increase government revenue in order to finance an expanding public sector. Tobacco tax was seen as one such potential source of revenue. Taxing an industry, as fragmented as the tobacco industry was, however, deemed unfeasible unless it was consolidated through nationalization. Moreover, the threat of the establishment of *British American Tobacco* – a company which had become a significant actor in neighboring countries – in Sweden served as a further impetus to nationalize the tobacco industry (Karlsson, 2008: 53-55).

Given the purpose of this paper, the characteristics of the Swedish tobacco industry at the end of the nineteenth century serve us well. A large number of firms were active in every year throughout the period and firm turnover was high enough to provide sufficient variation in the data for modelling survival. Heterogeneity stemming from differences in the technology used may be largely extent be discounted since no important innovations were introduced or adapted during the period studied. Firms produced similar products with no apparent economies of scale in a market where barriers to entry and exit were low and government intervention was non-existent. Raw tobacco leaves were mostly imported and there was no

vertical integration into tobacco farming, making the cost of raw material for firms almost identical for all the firms. Finally, since consumers did not interact directly with producers, nobody knew the gender of the individual who had manufactured the product, and thus there was no need to consider consumer preferences when hiring workers, granting firms more discretion when deciding whom to employ. In sum, our case discounts a number of factors associated with the employment of women that may otherwise complicate the analysis through unobserved heterogeneity.

Econometric analysis

Data and variables

Our analysis is based on data of all firms registered as active in the Swedish tobacco industry between 1863 and 1885. We have constructed the panel by collecting information from annual ledgers compiled by the *Swedish Board of Commerce*[2] as an intermittent step in the production of aggregated official statistics covering factories and manufacturers (Kommerskollegium kammarkontoret, 1863–1885). Firms are followed yearly between 1863 and 1885. Identification and linking of firms between years is based on the name of the firm. The ledgers helpfully recognize firms that change names by including both the old and new name of the firm in their listings, thus enabling us to accurately and consistently track firms over time. The detailed source material includes annual firm-level information on the firm's workforce (number of men, women, girls, boys and foremen employed), the legal form of the business, the types of machinery used and its power output measured in horse powers, the amount of tobacco produced by product category (cigars, cigarettes, snuff, chewing tobacco and smoking tobacco by weight and value) and the firms's geographical location. The registered firms range from small owner-operated firms to large factories employing hundreds of workers. The source material also includes firms that were only registered with the local authorities but never in operation. All the firms were single plant units and no firms owned subsidiaries. Because some firms enter before the first year of observation while others exit after the last year of observation, the year of establishment and demise for firms established prior to 1863 or exiting the industry after 1885 was obtained from a comprehensive directory over the Swedish tobacco industry (Angelin, 1950). To account for the Swedish industries competitiveness relative to the rest of the world, annual information on the volume of manufactured tobacco exports and imports is sourced from official trade statistics

(Kommerskollegii, 1863–1885). These measures are yearly industry indicators and, hence, identical for all firms in a given year.

In total, 268 firms were registered between 1863 and 1885. A majority of the firms were small and only employed a handful of workers. Such firms would often cease for periods before restarting production, resulting in intermittent appearances in the register. Furthermore, since most small firms were essentially workshops rather than factories, operations tended to cease once the proprietor retired or died. For modelling purposes, we only include firms that reached a minimum size of ten employees at any time in our dataset. This restriction and the exclusion of observations with missing information for any variable of relevance, yields a sample of 109 firms. Although restricting the sample by more than half may sound severe, in practice it is not so: the eliminated firms only contributed a small share to total industry output, producing less than eight percent of total output during the period of investigation. Descriptive statistics of both the full and restricted samples are presented in Table 1. The restrictions result in the average firm in the final sample being significantly larger in terms of workers employed, machinery utilized and output produced when compared to the total population of firms. Moreover, the firms in the restricted sample were more likely to operate as a limited liability company and employ a foreman but were only slightly more feminized than the total population of firms.

Table 1 about here

We assess firm longevity by considering firms that survive compared to those that exit the industry, controlling for a number of factors. A firm could cease to exist in a number of ways. We identified different reasons by supplementing the register-based data with information on the circumstances of the failure of each firm. Reasons included their being the subject of an acquisition, voluntary liquidation or bankruptcy, and finally - specific to our case - being nationalized as part of the Swedish Tobacco Monopoly in 1915. Because the source material uses the terms liquidation and bankruptcy interchangeably, we are not able to differentiate between these two types of failure. Although the underlying causes of takeovers are debatable, voluntary liquidation and bankruptcy are both in a similar way related to the viability of the firm, which is what we are ultimately interested in. We therefore treat liquidation and bankruptcy identically. Firms in our sample may thus have ceased to exist as a result of one of three possible outcomes:

1. Firm taken over by state as part of the nationalization of the tobacco industry in 1915.
2. Firm acquired by another firm.[3]
3. Firm exiting from industry because of voluntary liquidation or bankruptcy.

Our main explanatory variable of interest is the firm's employment of women. The most simple and straightforward measure of firm feminization is the share of women in the total number of employees in each firm. Using raw ratios does, however, raise concerns about spurious relationships. As shown in Figure 1, the average share of women employed by firms increased almost monotonically from 1863 until the nationalization of the industry in 1915. Because the firms and the Swedish tobacco industry as a whole became gradually more feminized during the period covered, raw ratios are highly time-dependent. If other variables that affected the survival of firms (such as disposable income, female labor force participation or tobacco consumption) increased accordingly over time any correlation between the firms' employment of women and survival may be spurious. To address these issues we construct a measure of female employment that is adjusted by the local level of feminization in each year[4]:

$$\dot{r}_{it} = \frac{r_{it} - \bar{r}_{it} + 1}{2} \quad (1)$$

where r_{it} denotes the share of women of firm *i* at time *t*, and $\bar{r}_{it}$ is the average share of female employees in tobacco manufacturing within a 50 km radius off each firm. A further concern is functional form, because the impact of employing women may be non-linear, something that has been shown both theoretically, when assuming friction in the labor market (Rosén, 2003), and empirically (Weber and Zulehner, 2009: Figure 4). Here, we allow for the impact on firm survival of employing women to vary in the distribution by coding the adjusted measure of feminization into four ordinal groups of firms delimited by quartiles (respectively labelled least feminized, moderately feminized, highly feminized and most feminized).The least feminized group of firms, with a level of feminization falling below the first quartile, is used as the reference category in all models.

Naturally, the success or failure of a firm is not solely determined by its hiring strategies pertaining to whom it chooses to employ but also contingent on a number of factors internal and external to the firm. Little evidence exists about general patterns of firm survival and its

determinants in historical settings. This lack of knowledge may be attributed to a scarcity of historical data on industries in their entirety, that is populations of firms. Fewbut nonetheless interesting exceptions include Thompson's (2005) study of the survival of firms in the shipbuilding industry from 1825 to 1914, Box's (2008) exploration of the impact of the economic environment on survival among seven birth cohorts of firms during the first half of the twentieth century, and Mackie's (2001) study of the survival prospects of family firms in Kirckaldy, Scotland, 1870–1970.

As a consequence of better data availability, including data from modern business registers, coupled with the applicability of increasingly sophisticated econometrics, the literature is more extensive on firm survival, and its determinants, in contemporary settings. A number of stylized correlations between survival and factors internal and external to the firm may be identified. The most generally observed determinants of firm survival are size and age, exemplified by high rates of failure among recently established and small firms, followed by declining rates in later periods (see e.g., Evans, 1987; Dunne, Roberts and Samuelson, 1988, 1989; Mata and Portugal, 1994). We control for firm size by including a variable indicating the number of workers employed by the firm along with a variable indicating output measured in 1,000 SEK (in fixed prices adjusted for inflation). Regarding output, a distinction is made between cigars, snuff, and cigarettes. Because of inconsistencies in the source material regarding the definition of chewing tobacco and smoking tobacco, the two categories have been merged into one (labelled 'other tobacco'). Based on the commonly observed relationship between firm size, age and survival, the number of employees is expected to have a negative effect on the hazard of failure. Although the general trend in the impact of output is predicted to be positive, the impact of individual categories of output is *a priori* more difficult to hypothesize about because some branches of tobacco manufacturing may have been more competitive than others.

The legal structure of the firm is related to its age and size. Firms typically start out as sole proprietors or partnerships before changing their legal status when reaching a more mature stage. Whether firms that operate under limited liability are more vulnerable than those under unlimited liability (or vice versa) seems, however, not unidirectional but highly dependent on context (Brüderl, Preisendörfer and Ziegler, 1992; Harhoff, Stahl and Woywode, 1998; Esteve-Peréz and Mañez-Castillejo, 2008). To account for differences in the legal form of the firm, a dummy variable is included that indicate whether the firm was registered as a limited

liability company (the reference category being sole proprietor or partnership). Possible differences in management practices are controlled for by the inclusion of a dummy variable denoting whether the firm employed a foreman or not. We interpret the reference category (no foreman employed) as an indication of the firm being managed by its owner. Although mechanization was limited, animals, steam engines or water were used in some cases to power mills for shredding tobacco. To alleviate concerns about mechanization driving the results, we include a variable indicating the number of horse powers employed by the factory.

Besides internal factors, the survival of firms is affected by environmental variables. Industry-specific characteristics such as competition and economies of scale together with the geographic location of the firm all result in differences in survival rates between firms (Manjón-Antolín and Arauzo-Carod, 2008: 18-20). The risk of failure is moreover correlated with the business cycle, being lower in times of industry expansion and elevated during downturns (Audretsch and Mahmood, 1995; Geroski, 1995; Caves, 1998; Disney, Kaskel and Heden, 2003). We consider these factors by including a number of control variables. The impact of general and location-specific environmental conditions is incorporated through the inclusion of the yearly growth rate in tobacco industry employment along with an identifier of the province in which the firm was located. Finally, the impact of competition from foreign firms is measured by a variable indicating imports and exports of manufactured tobacco products as a percentage of total domestic industry output.

Empirical model and results

To test whether the employment of women affected firm longevity, and, to account for the interdependence between the firm's age and its survival discussed at the beginning of this paper, duration models are employed. We begin by estimating standard Cox (1972)[5] proportional hazards models, treating both being subject of an acquisition or the industry's eventual nationalization as censoring events:

$$h(t|x) = h_0(t)*exp(\boldsymbol{\beta}\mathbf{X}) \qquad (2)$$

The first term in Cox' proportional hazards model, $h_0(t)$, denotes the baseline hazard of failure and corresponds to the probability that a firm whose explanatory covariates are all equal to zero will fail. The estimation of the model necessitates leaving the baseline hazard un-estimated. This, in turn, permits $h_0(t)$, the firms' baseline hazard of failure to increase,

decrease, remain unchanged or vary with time. The model thereby allow for any theoretically motivated survival pattern with regards to firm age. We thus remain agnostic about the specific relationship between age and survival and instead focus on the estimated parameters (**β**) for covariates (**X**) on survival. For ease of interpretation, we report all parameters as hazard ratios ($exp(\boldsymbol{\beta})$). A hazard ratio above one means an increase in the risk of failure, while a hazard ratio less than one denotes a decrease. For example, an estimated hazard ratio of 0.75 for a dummy covariate means that a firm fulfilling the dummy criterion at any point in time is 25 percent less likely to fail compared to a firm in the reference category. If the covariate in question is continuous, each unit change in the covariate will lead to reduction in the risk of failure by the corresponding hazard ratio. A five unit increase in a covariate with an estimated hazard ratio of 1.10 would thus imply a change in increased risk of failure by 61 percent (= 1.10^6).

The results from model estimations are presented in Table 2. We begin by estimating a very parsimonious model (I) with firm-level feminization as the only explanatory variable. Thereafter, we add control variables in a step-wise manner. With no controls, a the substantial reduction in the hazard of failure for more feminized firms is notable. When compared to the least feminized group of firms (i.e., the reference category), the risk of failure is reduced by 52 percent for moderately feminized firms; 71 percent for highly feminized firms; and 47 percent for the most feminized group of firms. It is likely that this effect may be attributable in part to excluded variables covarying with the employment of women. Hence, in Model II, we account for firm size by including the number of employees and output by value as covariates. The estimated hazards associated with these covariates are in line with expectations that both more employees and higher firm output lead to a reduction in the risk of failure. After including controls for firm size, the impact of employing women is somewhat weakened, indicating that more feminized firms also tended to be bigger. In Model III we add geographic controls in the form of province dummies to account for differences in firm survival based on location. In Model IV, we proceed by controlling for whether the firm was managed by a foreman, and registered as a limited liability company, and for the extent to which machinery was used in the production process. We find no significant relationship the firm's legal form and survival. Furthermore, machinery had no impact on firm survival. This result is in line with the characterization of the Swedish tobacco industry as being essentially artisanal in form and organization. Being managed by a foreman implies a highly elevated hazard of exit. Owner-managed firms were less likely to fail than those employing a foreman.

The final model (V) is the most extensive model, incorporating all control variables of previous models together with macro-level variables of the firm, potentially affecting its survival. The estimated effect of macro variables on firms are as expected: the hazard of failure is positively related to the business cycle (i.e., industry growth) and, although not statistically significant, imports are negatively associated with survival while exports are positively associated with survival.

Table 2 about here

Turning to the main variable of interest, feminization, we find that firms whose share of women was above the bottom quartile faced a significantly lower risk of failure than those whose share fell below that level. This is the case in all estimated models. In the most extensive model (V), relatively more feminized firms' hazards of exit are between 64 and 81 percent lower compared to the least feminized group of firms. In order to get a sense of the relative magnitude of these numbers, a comparison with the estimated hazards of other covariates is illustrative. The difference in the hazard of failure between the least feminized group of firms and the moderately feminized group (a difference of 64 percent) is equivalent to a decrease in hazard of failure associated with an increase in firm size by about 30 employees. An equivalent decrease in hazard associated with industry growth implies a year-by-year expansion of the tobacco industry by approximately 25 percent. Given that the average firm in the sample employed 52 workers (see Table 1) and that a yearly industry growth rate of 25 percent must be considered very favourable, it is clear that the importance of employing women relative to other factors was not only statistically but also economically significant. Interestingly, we find that the impact of feminization is non-linear: while employing more women than the least feminized category of firms resulted in a considerably lower risk of failure, no discernible further gain can be identified for firms feminizing beyond this threshold in terms of survival. The dynamics of the selection process is thus not to favor the forerunners of feminization in terms of survival but rather to eliminate extreme laggards among of firms.

A shortcoming of the standard Cox model is its failure to accommodate different forms of failure. In order to account for the different ways in which a firm in our sample could exit the industry and the effect this could have on the results, we extend the analysis by treating each form of exit as a distinct event. In our case the additional event in question is the firm being

subject to an acquisition, constituting a competing risk in that it prevents the occurrence of eventual failure through bankruptcy or liquidation. Employing a competing risks model acknowledges that firms may cease to exist from causes other than liquidation or bankruptcy. We estimate the following competing risks model suggested by Fine and Gray (1999):

$$h_j(t|x) = h_{j,0}(t)*exp(\boldsymbol{\beta}\mathbf{X}) \quad (3)$$

where $h_{j,0}(t)$, the sub-hazard of experiencing failure from one of j events in year t is again left unspecified (in our case $j=1$: exit due to liquidation or bankruptcy and $j=2$: exit due to acquisition). Alternative types of failure are thus treated not in terms of censoring but as separate events (acquisitions) preventing the outcome of interest (liquidation or bankruptcy) from occurring. As in the Cox model, our interest lay in the parameters ($\boldsymbol{\beta}$) which are reported as sub-hazard ratios ($exp(\boldsymbol{\beta})$).

The results from the competing risk analysis are presented in Table 3. Of the 109 firms in our sample, 10 were the subject of an acquisition, 65 failed and 34 were censored as a result of the industry's nationalization. The step-wise inclusion of control variables exactly mirrors what was presented in Table 2. None of our results are substantially altered after taking into account the multiple ways in which a firm may fail. When compared to the results estimated using the standard Cox model, the impact of the employment of women is slightly stronger and more precisely specified. In the most extensive model (V), the hazard of bankruptcy or liquidation among the most feminized firms is between 66 and 81 percent lower than the reference category.

Table 3 about here

The results of the estimated models are highly robust. We undertake a number of sensitivity tests. When replacing the measures of the Swedish tobacco industry's competitiveness relative to the rest of the world (i.e., annual information about the volume of manufactured tobacco exports and imports) with year dummies, our results hold up to the extent that the impact of the employment of women actually gets stronger. Moreover, the robustness of our results is tested by a re-estimation of the most extensive competing risks model (model V in Table 3) after imposing a number of restrictions. The results of various robustness checks are presented in Table 4. We begin by investigating whether the results are driven by segregated

firms by excluding firms that exclusively employed either women or men (see models I-III in Table 4). A further concern is that the estimated results may be driven by well-established firms that entered the industry before our first year of observation. To ensure that this is not the case we proceed by re-estimating the model only for those firms that entered during our observation period, thereby excluding all firms that entered the industry before 1863. The results are presented in column IV. Finally, to test to what extent the results are sensitive to following firms up to 30 years after the last year of observation, 1890 is used as an alternative year of censoring (in model V). It should be noted that, after applying the above restrictions, our results change little. Although some of the coefficients are estimated with somewhat less precision after applying the restrictions, the main results of the analysis remain consistent: the impact of female employment (i.e., firm-level feminization) on survival remains large, non-linear, and statistically significant.

Table 4 about here

Firm longevity and industry feminization

Our study has implications for how we regard firm longevity and industry feminization. Feminization of the workforce has alongside industrialization profoundly transformed the economy. However, the employment of women has not followed a uniform pattern historically. Although work in many industries was put increasingly into the hands of women during American and European industrialization, some occupations remained dominated by men while others experienced periods of de-feminization (e.g., Abbott, 1910; Bradley, 1989). A prominent explanation for why particular firms and industries feminized during the nineteenth century rests upon the assumption that female labour was complementary to technological change in the form of mechanization and the increasing division of labour and deskilling. Marx (1970 [1867]: 420) declared the onset of feminization of a workforce to begin when "machinery dispenses with muscular power, [at which point] it becomes a means of employing labourers of slight muscular strength, and those whose bodily development is incomplete, but whose limbs are all the more supple. The labor of women and children was, therefore, the first thing sought for by capitalists who used machinery". Goldin and Sokoloff (1982; 1984) provide a similar argument, but emphasize the role of increased demand for unskilled labour in the nineteenth-century manufacturing sector. Coupled with women's and children's inferior labour productivity and lower wages in the agricultural sector, feminization

is attributed to the relative cheapness of women's and children's labour coupled with de-skilling and the increasing division of labour resulting from the transition from artisan shops to factory production (cf. Gospel, 2007).

In this article, we do not directly dispute the reasons for feminization given by previous researchers. Instead, we argue that our results provide a basis for an alternative and complementary explanation for feminization based on competition and firm longevity. The extended longevity of more feminized firms coupled with the eventual feminization of the tobacco industry may be considered a case of *isomorphism,* a process that shapes a population to become increasingly compatible with its environment (Hawley, 1968). Isomorphism may be described as a constraining process that forces entities in a population to tend towards a resemblance of each other in line with survival of the fittest. Within an industry, competition provides the constraining mechanism that induces change and eventual homogenization. By favouring competitive firms and causing unprofitable firms to exit, competitive firms will, through their extended longevity, increasingly dominate an industry (Hannan and Freeman, 1977). It thus follows that an industry will with time increasingly come to display the attributes of its most competitive firms. Based on our analysis of female employment as being a competitive advantage, the difference in longevity between more and less feminized firms provides a previously neglected explanation for industry feminization. Our results show that the least feminized firms in the Swedish tobacco industry failed to a significantly greater degree than more feminized firms. In terms of survival it was highly detrimental not to employ women. Firms that did not employ women were continuously selected out of the population. No additional premium was, realized, however, by the forerunners of feminization. The elimination of the least feminized firms with no apparent further gain realized by firms that were very highly feminized is consistent with the fairly slow and gradual replacement of men by women over the period depicted in Figure 1. While markets were clearly efficient enough to favour firms that feminized, the effect of the differences in survival between more and less feminized firms on the composition of the industry workforce was not radical. Instead, a persistent but slow movement towards equilibrium over a relatively long period of time can thus be observed.

Concluding discussion

In this article, we have explored whether the employment of women was a strategic decision among employers during industrialization. Our results are robust against the inclusion of a number of relevant control variables and hold both when employing a standard Cox model and when considering the role of competing risks. The results are not diminished by subjecting the models to several sensitivity tests. We focused on tobacco firms' employment decisions during the second half of the nineteenth century and how it affected the gender composition of the industry as a whole. This study demonstrates that during nineteenth-century industrialization firms which employed relatively more women than their competitors faced a considerably lower risk of failure. Since firms that were more feminized than their competitors were more likely to survive, the least feminized firms' long-term position in the market were untenable.

It is important to emphasize that the impact of employing women above men is large: firms that failed to feminize thus faced severe repercussions. Firstly, this tells us something about firm survival and nineteenth-century markets. There are numerous *a priori* reasons why nineteenth-century markets should be less efficient than what may be the case in a modern setting. While significant inefficiencies were likely to exist because of limited means of transportation and high costs of information, such obstacles to competition were remedied by liberal labor laws and low material and regulatory barriers to entry and exit. This contributed to make markets efficient enough to reward firms that acted in accordance with profit maximization and adapted to market competition. Secondly, because the survival prospects of the least feminized firms were substantially poorer relative to more feminized firms, the incentives for capable firms to feminize were high enough to act upon. Industry feminization may thus be seen as a result of two related processes: the continuous elimination of the least feminized firms in the distribution which directly affected the share of men employed in the industry negatively. This implicit threat of failure, in turn, served to incentivize surviving firms to employ even more women, thereby affecting the average share of women employed in individual firms and the industry as a whole positively.

The period considered in this paper stands in sharp contrast to that which followed. After the nationalization of the Swedish tobacco industry in 1915, mechanization brought a second transformation of the industry's workforce driven by rationalization and personnel reductions, a common development mirrored by, for example, the American tobacco industry (Cooper, 1987). The transformation of the Swedish tobacco industry prior to 1915 – from a male-

dominated to a female-dominated workforce – was much more subtle by nature. Prevailing explanations for nineteenth-century feminization processes typically attribute the increasing employment of women to changes in production processes associated with the Industrial Revolution. In contrast to this, the present study emphasizes competition between firms as a powerful mechanism behind feminization. As exemplified by the Swedish tobacco industry, technological and organizational changes were not prerequisites for feminization. Instead, given sufficiently efficient markets, feminization resulted from a competitive process that unfolded during several decades, a process distinctly different from the industry-wide technologically induced transformation of an industry's workforce.

With regards to the literature reviewed, the evidence presented here corroborates both historical witness accounts of nineteenth-century hiring practices and contemporary studies of the impact of employing women in a modern setting. That the least feminized firms in our sample were not viable in the long run lends credibility to the cited claims made by nineteenth-century observers that women were hired in place of men in order to increase a firm's competitiveness. Moreover, the results are consistent with modern findings showing that more feminized firms generate higher profits and, by extension, are less likely to fail. Given the consistency of our results with modern quantitative studies and qualitative historical evidence, we have good reason to surmise that our conclusions have bearings on firm survival, firm longevity, and the feminization of labour in a wider historical setting.

Finally, from a methodological perspective this study demonstrates the value of considering complete populations by using individual firms as the unit of analysis when seeking to explain not only the inner workings of competition within industries but also changes to society at large. We therefore argue that studies attempting to explain overall patterns should, to a greater extent, explicitly consider how processes at the micro-level shape long-term aggregate trends.

Endnotes

[1] Thus, cigarettes remained a marginal product until after nationalization in 1915, which marks the end of our study.

[2] Authors translation, original name: *Kommerskollegii.*

[3] One single firm, which entered the industry in 1883, was recorded by Angelin (1950) to have merged with another firm (that entered after 1885). We treat this firm as having been the subject of an acquisition. Whether we treat the merger as an acquisition, a liquidation or bankruptcy, or consider the new firm that resulted from the merger as a continuation of the original firm founded in 1893, makes no difference to the results.

[4] Our approach is thus similar to that advocated by Weber and Zulehner (2009) but instead of adjusting by an industry average, we adjust by the local level of feminization.

[5] The model requires two key assumptions: non-informative censoring and proportional hazards. It is plausible that being the subject of an acquisition does not constitute a case of non-informative censoring. This concern is explicitly dealt with when we proceed to modeling competing risks. The proportional hazards assumption requires that all covariates are time-independent, that is, that the effect (β) of a covariate is constant throughout a firm's life. In contrast to the non-informative censoring assumption, the fulfillment of the proportional hazards assumption may be evaluated empirically. Tests of the proportional hazards assumption based on Schoenfeld residuals confirm that the assumption of proportionality is not violated.

[6] A sub-hazard differs from the regular hazard in the Cox model by being the instantaneous probability of failure from a specific cause at a point in time given no failure from such cause prior or having failed but from an alternative cause prior. The Fine and Gray (1999) approach to estimating sub-hazards accounts for competing risks by keeping subjects that fail from a competing cause in the risk population using a time dependent weighing function.

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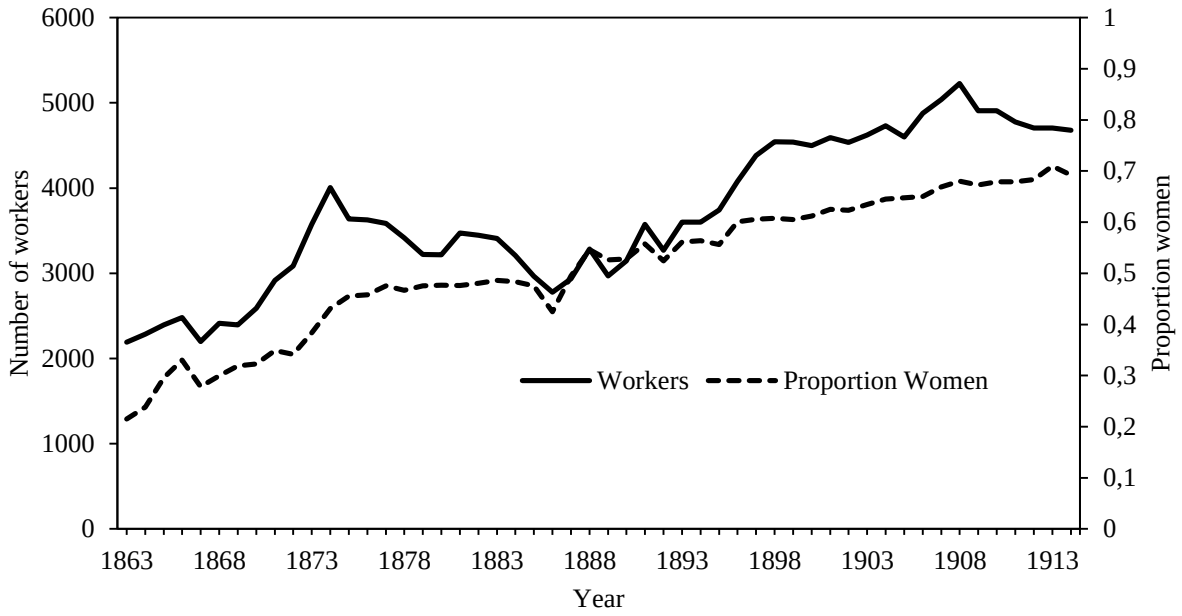
Figures

Figure 1. Industry employment and share of women in the Swedish tobacco industry, 1863–1913.



Sources: Kommerskollegi, *Bidrag till Sveriges Officiella Statistik: Fabriker och handtverk* (Stockholm, 1863–1912), and Kommerskollegium, *Industri* (Stockholm, 1913–1914).

Tables

Table 1. Descriptive statistics of firms explored in the empirical analysis.

	All observations (268 firms)					Restricted sample (109 firms)				
	Mean	Std. Dev.	Min.	Max.	Obs.	Mean	Std. Dev.	Min.	Max.	Obs.
Workforce										
Women	8.972	26.903	0	299	2,051	15.434	34.244	0	299	1,168
Employees	30.958	58.310	0	401	2,051	51.931	70.253	1	401	1,168
Output ('000 SEK)										
Cigars	28.453	66.519	0	444.881	2,051	48.047	82.497	0	444.881	1,168
Cigarettes	0.048	0.853	0	33.024	2,051	0.084	1.130	0	33.024	1,168
Snuff	33.360	88.706	0	970.086	2,051	50.179	111.274	0	970.086	1,168
Tobacco	23.701	53.831	0	542.779	2,051	40.843	66.302	0	542.779	1,168
Management										
Foreman	0.354	0.478	0	1	2,051	0.586	0.493	0	1	1,168
Limited liability	0.263	0.441	0	1	2,051	0.370	0.483	0	1	1,168
Machinery										
Horse powers	2.337	6.837	0	100	2,048	3.780	8.641	0	100	1,168

Sources: Kommerskollegium kammarkontoret (1863-1885), *Årsberättelser fabriker serie 4*, Da4, vol S05823–44, vol S02054–61 and vol S05806–19, Kommerskollegiets arkiv, National Archives (*Riksarkivet*), Stockholm.

Table 2. Estimations of hazard ratios of failure from Cox's proportional hazards models.

	I		II		III		IV		V	
Level of feminization										
Moderate	0.473	**	0.672		0.450	**	0.420	**	0.342	***
	(0.163)		(0.224)		(0.181)		(0.169)		(0.141)	
High	0.291	***	0.400	***	0.264	***	0.254	***	0.223	***
	(0.112)		(0.131)		(0.119)		(0.113)		(0.101)	
Most feminized	0.532	**	0.610		0.458	**	0.430	*	0.378	**
	(0.169)		(0.210)		(0.177)		(0.186)		(0.170)	
Workforce										
Employees			0.973	***	0.973	**	0.960	***	0.964	***
			(0.010)		(0.011)		(0.012)		(0.014)	
Output ('000 SEK)										
Cigars			1.003		1.003		1.002		1.000	
			(0.004)		(0.005)		(0.006)		(0.008)	
Cigarettes			1.036		1.060		1.034		1.021	
			(0.048)		(0.052)		(0.048)		(0.047)	
Snuff			0.993		0.986		0.986	*	0.988	
			(0.005)		(0.010)		(0.008)		(0.008)	
Tobacco			0.980	**	0.975	**	0.970	**	0.971	**
			(0.008)		(0.012)		(0.013)		(0.014)	
Management										
Foreman							3.392	***	3.098	**
							(1.328)		(1.364)	
Limited liability							1.203		1.051	
							(0.392)		(0.376)	
Machinery										
Horse powers							0.999		0.992	
							(0.008)		(0.008)	
Macro variables										
Industry growth									0.961	**
									(0.016)	
Exports									0.745	
									(0.164)	
Imports									1.032	
									(0.020)	
Location										
Province dummy	No		No		Yes		Yes		Yes	
Firms	109		109		109		109		109	
Firm years	1,168		1,168		1,168		1,168		1,168	
No of failures	65		65		65		65		65	
No of censored firms	44		44		44		44		44	
$\chi 2$	11.720	***	44.998	***	140.749	***	2063.591	***	185.122	***

Notes: Robust standard errors clustered by firm in parenthesis. Significance levels: * 10 percent, ** 5 percent, *** 1 percent.

Sources: Kommerskollegium kammarkontoret (1863-1885), *Årsberättelser fabriker serie 4*, Da4, vol S05823–44, vol S02054–61 and vol S05806–19, Kommerskollegiets arkiv, National Archives (*Riksarkivet*), Stockholm, and Kommerskollegi, *Bidrag till Sveriges Officiella Statistik F, Utrikes handel och sjöfart* (Stockholm, 1863–1885).

Table 3. Estimations of sub-hazard ratios of failure from proportional hazards model with competing risks.

	I		II		III		IV		V	
Level of feminization										
Moderate	0.462	**	0.667		0.441	**	0.428	**	0.338	***
	(0.139)		(0.221)		(0.177)		(0.171)		(0.138)	
High	0.258	***	0.348	***	0.219	***	0.219	***	0.191	***
	(0.089)		(0.116)		(0.099)		(0.099)		(0.087)	
Most feminized	0.472	**	0.535	*	0.394	**	0.377	**	0.329	**
	(0.143)		(0.189)		(0.154)		(0.165)		(0.152)	
Workforce										
Employees			0.969	***	0.970	**	0.958	***	0.960	***
			(0.011)		(0.012)		(0.012)		(0.014)	
Output ('000 SEK)										
Cigars			1.005		1.004		1.004		1.002	
			(0.004)		(0.005)		(0.006)		(0.008)	
Cigarettes			1.038		1.061		1.036		1.025	
			(0.049)		(0.052)		(0.048)		(0.047)	
Snuff			0.995		0.988		0.988		0.990	
			(0.004)		(0.009)		(0.008)		(0.007)	
Tobacco			0.983	**	0.978	*	0.975	*	0.976	*
			(0.008)		(0.012)		(0.014)		(0.014)	
Management										
Foreman							3.228	***	2.926	**
							(1.249)		(1.288)	
Limited liability							1.084		0.932	
							(0.370)		(0.352)	
Machinery										
Horse powers							1.004		0.995	
							(0.008)		(0.008)	
Macro variables										
Industry growth									0.964	**
									(0.016)	
Exports									0.756	
									(0.166)	
Imports									1.039	*
									(0.021)	
Location										
Province dummy	No		No		Yes		Yes		Yes	
Firms	109		109		109		109		109	
Firm years	1,168		1,168		1,168		1,168		1,168	
No of failures	65		65		65		65		65	
No of competing	10		10		10		10		10	

No of censored	34		34		34		34		34	
$\chi 2$	18.971	***	44.933	***	523.563	***	1094.497	***	761.001	***

Notes: Robust standard errors clustered by firm in parenthesis. Significance levels: * 10 percent, ** 5 percent, *** 1 percent.

Sources: See Table 2.

Table 4. Sensitivity tests of estimations of sub-hazard ratios of failure from proportional hazards model with competing risks.

	I		II		III		IV		V	
Level of feminization										
Moderate	0.513		0.314	***	0.472		0.303	**	0.466	*
	(0.242)		(0.135)		(0.240)		(0.150)		(0.209)	
High	0.217	**	0.184	***	0.215	**	0.103	***	0.152	***
	(0.142)		(0.087)		(0.151)		(0.061)		(0.091)	
Most feminized	0.377	*	0.295	**	0.338	*	0.336	**	0.394	*
	(0.191)		(0.145)		(0.189)		(0.172)		(0.194)	
Workforce										
Employees	0.946	***	0.962	**	0.947	***	0.956	***	0.945	**
	(0.013)		(0.015)		(0.013)		(0.014)		(0.022)	
Output ('000 SEK)										
Cigars	1.004		1.001		1.004		1.003		1.009	
	(0.006)		(0.008)		(0.006)		(0.006)		(0.012)	
Cigarettes	1.030		1.022		1.028		1.029		1.034	
	(0.043)		(0.045)		(0.041)		(0.048)		(0.047)	
Snuff	0.992		0.989		0.992		0.990		0.990	
	(0.009)		(0.007)		(0.009)		(0.019)		(0.013)	
Tobacco	0.987		0.976	*	0.986		0.981		0.976	
	(0.013)		(0.014)		(0.013)		(0.023)		(0.025)	
Management										
Foreman	2.772	*	3.580	***	3.281	*	2.442	*	2.444	*
	(1.465)		(1.683)		(2.018)		(1.168)		(1.198)	
Limited liability	1.021		0.913		0.963		0.996		1.197	
	(0.432)		(0.369)		(0.448)		(0.478)		(0.486)	
Machinery										
Horse powers	1.000		0.996		1.001		0.987		0.974	
	(0.011)		(0.009)		(0.012)		(0.011)		(0.023)	

Macro variables										
Industry growth	0.969	*	0.958	**	0.959	**	0.985		0.968	**
	(0.017)		(0.018)		(0.020)		(0.013)		(0.016)	
Exports	0.874		0.764		0.873		0.878		0.731	
	(0.207)		(0.174)		(0.207)		(0.210)		(0.167)	
Imports	1.015		1.032		1.009		1.023		1.023	
	(0.028)		(0.021)		(0.030)		(0.019)		(0.024)	
Location										
Province dummy	Yes		Yes		Yes		Yes		Yes	
Censoring year	1915		1915		1915		1915		1890	
Sample restrictions										
Excluding all-male firms	Yes		No		Yes		No		No	
Excluding all-female firms	No		Yes		Yes		No		No	
Excluding pre-1863 entrants	No		No		No		Yes		No	
Firms	95		108		94		65		109	
Firm years	893		1,136		867		437		1,168	
No of failures	50		61		47		48		53	
No of competing	10		10		10		7		5	
No of censored	35		37		37		10		51	
$\chi 2$	1048.500	***	1399.322	***	1400.298	***	504.652	***	1003.567	***

Notes: Robust standard errors clustered by firm in parenthesis. Significance levels: * 10 percent, ** 5 percent, *** 1 percent.

Sources: See Table 2.