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WOLF-FABIAN HUNGERLAND
HUMBOLDT-UNIVERSITY OF BERLIN

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THE AUSTRALIAN NATIONAL UNIVERSITY
ACTON ACT 0200 AUSTRALIA
T 61 2 6125 3590
F 61 2 6125 5124
E enquiries.eco@anu.edu.au
https://www.rse.anu.edu.au/research/centres-projects/centre-for-economic-history/

German Export Survival in the First Globalisation*

Wolf-Fabian Hungerland†

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Abstract

How were trade relations structured in the first globalisation? Previous literature has highlighted the strong activity of the extensive margin during the first globalisation, i.e. that there was substantial entry and exit. However, so far little is known about what happens between market entry and exit. Traditional narratives of the first globalisation relying on the Heckscher-Ohlin factor endowments or the gravity model are mute about these features of the data. In this paper I study the survival margin of international trade and wonder how long trade relationships lasted and what factors mattered for the duration of exports. Using product-level export data from 1889 to 1913, I find that the first years of an export were the most hazardous. The median length of an export spell was 2 years, only about 60 percent survived the first year, and a mere third of exports lasted longer than 3 years. However, once exporters survived the first two years they face less hazard from year to year. I take Rauch and Watson's (2003) search cost model of trade relationships and derive hypotheses that I test in order shed light on the duration of Germany's exports. Key to this model is that a fraction of exports serve to learn about market conditions. I quantify this learning, and my findings suggest that search costs as well as reliability turn out to have been important for export survival, and so did prior export experience. In other words, learning to export was a salient feature of Germany's experience in the first globalisation.

JEL classification: F14, F19, N73, O14
Keywords: Survival margin, exports, first globalisation, Imperial Germany

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†Email: hungerlw@wiwi.hu-berlin.de. Institute of Economic History, School of Economics and Business, Humboldt-University of Berlin, Spandauer Strasse 1, 10178 Berlin, Germany.

1 Introduction

> '*We must export; either we export goods or we export people. With our increasing population, if we do not have a similar increase in industry at the same time, we will not be able to continue to exist.*'
>
> — Chancellor Leo von Caprivi in a Reichstag address, 1891
>
> (cited in Torp, 2014, p. 411)

Germany gained its first significant momentum as an export-oriented economy during its 'second industrialisation'. This period, to which the German historiography also refers to as 'high industrialisation' or Germany's 'first *Wirtschaftswunder*' (Wehler, 2006, p. 596), started with the foundation of the German Empire in 1871 and ended with World War I. It coincided with rapidly falling transport costs due to the spread of steam and other technologies and growing trade around the globe – the first globalisation.

In this period, the production of chemicals, machines and electro-technical products as well as consumer goods expanded massively – and so did exports of these sectors. From 1880 to 1913, the size of the German economy tripled, while exports grew even stronger: They rose from 3.2 to 10.2 billion marks.[1] Germany's second industrialisation was also an export-led industrialisation. At the eve of World War I, German industrial production was the second biggest in the world, just behind the United States and ahead of Britain (Burhop, 2011). Germany had become an industrial heavyweight among the leading economies of the world. This position, in turn, hinged on Germany's growing engagement in selling goods abroad, as the quote by chancellor Caprivi, Bismarck's successor, indicates.

How this growing export engagement can be characterised is, however, still and to an unsatisfying extent, a black box. Most quantitative histories of Germany's trade expansion draw on aggregated data only, that is, data at the sector or industry level (e.g. Jasper, 1996). This precludes to account for what numerous qualitative accounts of individual companies (and their products) as well as anecdotal evidence suggest:

[1] In deflated 1913-marks.

German exporters actively tried to adapt to market conditions abroad and to learn about the desires of their clients. This meant, in turn, exporters faced search costs amid uncertainty over demand. But a systematic exploration of these aspects of Germany's export growth is yet missing.

Traditional narratives of the first globalisation that rely on the Heckscher-Ohlin factor endowments theory or the gravity model are largely mute about these phenomena. Both narratives implicitly assume that trade relations are very persistent, and that exporters know where to sell what and how much of it. However, once we zoom into more granular historical trade data, notably on the product level, substantial variation becomes visible. For example, recent literature on Belgium's or Japan's experience during the first globalisation based on SITC three-digit data highlights a strong activity of the extensive margin during the first globalisation, i.e. that there was substantial market entry and exit (Huberman *et al.*, 2017; Meissner and Tang, 2017). In the light of trade theory that incorporate firm level heterogeneity (Melitz, 2003), the interpretation of this data feature is that market entry costs had to be overcome and that firm-level productivity differences correspond to the ability to cope with entry costs.

What—to the best of my knowledge—has not been studied so far, however, is what happened *in between* market entry and exit. In other words, there is still much to learn about how exporters performed after they entered a market, how long trade relations lasted or what factors mattered for the duration of exports. Knowing about these features helps us understand better Germany's globalisation experience, to quantify what we know from the qualitative historiography, and more generally to investigate why and how the first globalisation unfolded.

Against this background, I examine the survival margin of Germany's exports during this period. To do so, I use a novel dataset on Germany's exports from 1889 to 1913, that is highly disaggregated: It comprises exports on the product level to all destinations. The data exhibits substantial variation at the survival margin, and I draw on Rauch and Watson's (2003) search cost model of trade relationships to derive hypotheses that I test in order explore possible reasons for this variation.

I find that the first years of an export were the most hazardous. The median length of an export spell was 2 years, only about 60 percent survived the first year, and a mere third of exports lasted longer than 3 years. However, once exporters survived the first two years they face less hazard from year to year. Key to the Rauch and Watson's (2003) is that a fraction of exports serve to learn about market conditions. I quantify this learning, and my findings suggest that search costs as well as reliability turn out to have been important for export survival, and so did prior export experience. In other words, learning to export was a salient feature of Germany's experience in the first globalisation.

The remainder of this paper is as follows. Section 2 discusses the related literature and derives testable hypotheses. Section 3 describes the data and covariates. Section 4 contains the empirical analysis. Section 5 concludes.

2 Related Literature

2.1 Historiography

The dominating narrative of first globalisation is that trade unfolded along the lines of comparative advantage based on differences in factor endowments (O'Rourke and Williamson, 1999). During the 'great specialisation' economies around the world developed in tight interaction with what they imported and exported. However, the unit of analysis of this narrative are countries or very broadly defined industries.

Against this background, the typical historical application of this theory yields rather stark predictions on how an economy specialises.[2] Also most historical applications of the gravity model of international trade rely on aggregate data and focus on the intensive margin of international trade, that is, the volume of existing trade relations.

[2] In their simpler forms these models predict complete specialisation along with countries importing goods simply from the cheapest supplier. Moreover, such models fail to handle the fact that even on the most aggregate level, a substantial amount of potential trading relationships between countries are inactive (Helpman *et al.*, 2008). Advanced models of comparative advantage including trade frictions and a continuum of goods, however, account for these stylised facts better. But they remain the exception in historical research so far.

This is unsatisfying because with these models it is difficult to explain many phenomena that disaggregated datasets for this period exhibit (Meissner, 2015). More precisely, the substantial variation of market entry and exit as well as varying degrees of export survival at the product level remain unexplained. These features, however, loom large in Germany's globalisation experience ahead of World War I, as I will show below.

The German economic historiography emphasises that domestic factors such as human capital formation and close links between industry and finance fostered productivity growth, which then led to growing exports (see Burhop, 2011, for a survey). Cartelisation and protectionism dominate much of the narrative (Webb, 1977, 1980). Yet, many excelling export sectors remained unprotected and other countries implemented protectionist policies too, so that it is questionable whether these two phenomena provide a sufficiently exhaustive explanation of Germany's rising commercial power (Dedinger, 2006).[3] Others put forward how intra- and inter-industry spillovers stimulated innovation, highlighting the experimental character of industrial development.[4] Yet it remains an open question to what extent such spillovers help explain Germany's export growth more directly.

Research in transnational business history suggests that 'empires of business' were an important feature of the global economy already in the first globalisation (Fitzgerald, 2015). Globally active companies followed very different strategies in the markets they were operating in. Especially outside Europe, exporters needed to invest much more in local cooperation than in Europe. Many British, Dutch or French 'business

[3] Dedinger (2006) argues that the protections shift in 1879 did not have the objective to promote infant industries of the second industrial revolution. She concludes that '[t]he particular brand of German protectionism at the end of the nineteenth century decidedly influenced the course of only a handful of industries during this period: rye and wheat growing, cotton spinning, pig iron smelting and also perhaps rail making, [...] Apart from rye [...] none of these products figure among the goods that made the reputation of "made in Germany" goods, and so frightened Germany's competitors. [...] On the whole, the 1879 tariff provided only marginal protection to the vast majority of agricultural and industrial producers, which accounts for the absence of any discernible correlation between the level of protection and the changing pattern of comparative advantages' (p. 240).

[4] For example, Labuske and Streb (2008) show how the mechanical engineering industry grew competitive through technological creativity. Cramer (2015) argues that a 'co-evolutionary framework of science, firms, and institutions' explains rise of the chemical industry. Streb *et al.* (2006) find that inter-industry knowledge spillovers between industries were a 'major source' of innovation. Streb *et al.* (2007) confirm this, using the interaction between the 'new' chemical industry and the 'old' textile industry.

empires' were supported in doing so by political empires. This, however, held much less for German exporters: The German Empire lacked the long-established colonial underpinnings to so support its internationally operating companies in a way the British or Dutch government was able to. The quantitative implications of this for Germany's exports remain, however, unexplored to date.

Most related to this paper are more qualitative studies of Germany's engagement in international trade. Business historians suggest that there is something to learn from more 'micro' data about the pattern of international trade: Many German exporters entered smaller and far-away markets early in the product cycle, invested in market intelligence as well as reputation building, and generally undertook substantial initiative to expand market shares abroad.[5] Chandler (1994, p. 410f) summarises this noting that the particular organisational capabilities of German firms gave them 'powerful advantages in international competition', and quotes Alfred Marshall (p. 42):

> 'Germans excel in the sedulous adoption of their manufactures to local needs, high and low. They are quick to take account of differences in climate, of taste and custom, and even superstition [...] And with equal patience they get to know enough of the business affairs of individual traders to be able to sell with relatively small risk on long credit, with Englishmen sometimes demand prompt payment. In all this they are much aided by the industry in acquiring languages of Eastern Europe, Asia, and South America. Even in markets in which English is spoken they push that way by taking travel in small things to which the Englishman will not always bent.'

Contemporaries observed that German exporters seemed to have been doing well not only in terms of 'conquering' markets but also in terms of 'holding them'. For example, the British Brazil-based Consul Cowper wrote that the 'secret of German success is their thorough training as mercantile men' (British Foreign Office, 1887, p.

[5] See, for example, the history of Siemens, one of the earliest 'global players' of the German Empire (Feldenkirchen, 1995, ch. 1 and 2).

5). German travelling salesmen distributed their catalogues, price lists and labels of their manufacturers in Spanish and Portuguese. Other contemporaries noted that German commercial education, with extensive training in economics, law, geography, languages and other highly-specialised subjects, and the rising commercial success of the German economy abroad are closely linked (see, for example, Pogson, 1903). All these piecemeal aspects of exporting are hard to quantify, but they are likely to have contributed to Germany's rapid export expansion ahead of World War I. Systematic evidence on the microeconomic dynamics that supports such observations is still missing.

2.2 Stylised Facts from the Trade Literature

If we want to understand the how product-level trade relations were structured in terms of length, the global as well as the German narrative of the first globalisation remain—at least in parts—unsatisfying. However, more recent research in international trade has established multiple dimensions of heterogeneity on the micro level, which have been incorporated into theoretical and empirical treatments.[6] The unit of analysis of this newer literature is the firm or the product. While the German historical trade data underlying this paper does not observe the former, it observes the latter on the SITC five-digit level. This enables us to explore at least some of the microeconomic heterogeneity embodied in German exports. The following summarises the relevant stylised facts we know from the recent literature on international trade, before Subsection 2.3 derives hypotheses that are testable with the present dataset and that help understand better what we see in the data.

The first branch of the relevant literature puts forward the idea that comparative advantage is complex and dynamic. Economies specialise and diversify on the product level at the same time amid uncertainty about what an economy is—and can be—good at making: What you export matters (Hausmann *et al.*, 2007).[7] Hausmann and

[6] See Melitz and Redding (2014) and Head and Mayer (2014) for technical surveys or Helpman (2011) for a non-technical survey.

[7] Which, in turn has has important implications for economic growth. See also (Klinger and Lederman, 2006) as well as the literature based on network analysis spawned by Hidalgo *et al.* (2007).

Rodrik (2003) call this search for comparative advantage '(self-)discovery'. Redding (1999) argues that there is a trade-off between specialising according to current comparative advantage and entering sectors currently lacking comparative advantage. Entering sectors without current comparative advantage may actually yield productivity gains so that comparative advantage can be acquired, while not doing so may cause welfare losses – particularly when an economy is developing.[8] The unfolding of comparative advantage is conditional on frictions to trade, as Eaton and Kortum (2002) lay out in their seminal paper.[9]

The second branch of the relevant trade literature argues that productivity differences between firms correspond to variation in entry to and exit from foreign markets – the extensive margin of trade. Exporters have to cover fixed entry costs of exporting next to *ad valorem* trade costs. Entry costs are uncertain and so is which firms 'make it' abroad and which do not (Melitz, 2003). Depending on the definitions of the margins, most empirical evidence suggests that adjustment at the intensive margin—trade that gets more or less intense within existing trade relationships—dominates adjustment at the extensive margin (Hummels and Klenow, 2005; Besedeš and Prusa, 2011; Ruhl and Kehoe, 2013). This appears to be different in the first globalisation: Market entry was more prominent (Huberman *et al.*, 2017; Meissner and Tang, 2017).[10]

While gravity—distance, market size etc.—helps explain entry, a growing number of studies emphasize the role of uncertainty in exporting and highlight trade-promoting learning effects after entry. Segura-Cayuela and Vilarrubia (2008) extend the Melitz-model with informational externalities. They assume that post-entry performance reveals information to other exporters, who then decide whether to enter or not. Morales *et al.* (2017) argue that 'extended gravity', i.e. when new export destinations are similar to previous export destinations, reduces entry costs substantially. Defever *et al.* (2015) show that firms serve new markets which are close to their prior export

[8] Redding (2002) confirms this empirically, highlighting that a country's pattern of specialisation is subject to 'substantial mobility'.
[9] Harrigan and Deng (2010) show how trade frictions can determine the quality of the exported products, which in turn yields 'local' comparative advantages. See also Hummels and Skiba (2004).
[10] Appendix **??** presents descriptive statistics on market entry and exit.

destinations with a higher probability than standard gravity models predict. In their words: there is 'spatial exporting'.

More related to the present paper are studies on the survival margin that follow this line of reasoning with firm level data. Survival abroad is higher for experienced exporters (Albornoz *et al.*, 2016) and experienced exporters tend to expand sales and reach a larger number of destinations after entry (Albornoz *et al.*, 2012). Such 'sequential exporting' makes initial market entry costs worthwhile despite low survival probabilities. Others argue that information spillovers within and between firms help improve survival (Görg *et al.*, 2012; Cadot *et al.*, 2013). All this resonates with Das *et al.*'s (2007) argument that low survival does not necessarily mean welfare losses, if it reflects 'experimentation' at the extensive margin.[11] Such experimentation also corresponds to churning, i.e. the frequently changing export mix of a country on the product level – another common feature in modern micro trade data (Daruich *et al.*, 2016). Churning can trigger a virtuous cycle of entry and survival if enough exporters target one market simultaneously (Easterly *et al.*, 2009), and export survival corresponds to the life-cycle dynamics of products, which are *ex ante* unknown (Gumpert *et al.*, 2017).

2.3 Testable Hypotheses

Most related to this paper is the literature that focuses on the survival margin of trade using product-level data. Mounting empirical evidence suggests that survival of these flows is generally short, but also that the surviving trade flows account for a disproportionally large amount of trade (Besedeš and Prusa, 2006a,b; Nitsch, 2009). Besedeš (2008), using US import data, shows that most initial imports are likely to be short and of small value.

Many of theses studies draw on predictions from Rauch and Watson's (2003) matching model of international trade relationships. This model takes the firm as unit of analysis, and is built from an importer's perspective. In the model, a developed coun-

[11] If sunk costs of entry and exit are substantial, however, welfare losses are high.

try importer's goal is to find a developing-country supplier that is able to cater large orders. For the purpose of the present paper, I interpret the model from an exporter's perspective and at the product level.[12] Assuming that search is costly and match quality (or 'reliability' as they call it) varies, the model can account for both small starting and short-lived relationships, why duration varies across suppliers as well as how starting size and duration are related. A key point of this model is that it assumes that there are trade relations that are about generating profits and trade relations that are—at least initially—about learning, especially when uncertainty is high. That is, once an exporter entered a market, she must decide whether to sell more to the importer – or the importing market in the present case. The more reliable the market environment is and the lower search costs for new or additional buyers within this market are, the longer a trade relation should last. Rauch and Watson (2003) also highlight the size of initial export values, which mirror high confidence that the relationship should last longer. On the flip-side, the importer's reliability can be learned over time via small sales, or in their words: by starting small in an unfamiliar environment.

From the above, the following hypotheses can be derived that are testable with the Imperial German export data:

H1: *Some exports started small and others large, and large starting flows lasted longer.*

Rauch and Watson (2003) do not quantify what 'small' and 'large' means. This means that I will have define these sizes dimensions. In the survival analysis, we should expect lower hazard rates for high-value first-time exports.

H2: *Some exports were about learning, and these exports ended faster.*

[12] In my interpretation of the model I draw on Besedeš's (2008) and Besedeš and Prusa's (2006b) adoptions of the model for importers. Besedeš and Prusa (2006b) use the Rauch and Watson (2003) model to explore the role product differentiation using Rauch's (1999) classification of goods. Despite that Chapter **??** presents an application also to the present data, I refrain from focusing on using the product differentiation of Rauch (1999) because its application would require a large re-classification of first globalisation goods and their modes of exchange. This is the reason why I only draw on implications from the Rauch and Watson (2003) model that are testable without requiring Rauch's (1999) classification.

In the survival analysis, we should thus expect higher hazard in early stages of an export relationship, particularly for relationships that started small. The risk of failure should decline the longer the relationship.

H3: *The more reliable the importer was, the longer the duration.*

'Reliability' also needs to be defined. I follow Besedeš's (2008) application and interpret the importers' market size as a proxy for reliability. Larger economies should exhibit higher reliability since these economies, are typically richer, have stronger institutional underpinnings and more room for financial manoeuvre. That is, larger market size should coincide with longer export duration. Moreover, a stable exchange rate corresponds to more reliability, especially when considering pricing. In the present context, this implies that if an economy is adhering to the gold standard, we should expect longer export relations.

H4: *The lower the search cost were, the longer the duration.*

Because I not observe firm-level variation that would be necessary to capture exporters search costs directly, I consider classic frictions to trade as in the gravity literature—distance, a common border, etc.—as well as other market characteristics that proxy search costs, such as cultural similarity or whether diplomats specialising in trade-promotion were present. Section 3 explains these data in more detail.

Below I re-assess Germany's first globalisation experience against the background of these hypotheses. I evaluate the latter, step by step, and with a survival analysis based on Kaplan-Meier survival rates as well as by Cox proportional hazard estimations. But before doing so, let us take a look at the export data and the covariates I use.

3 Data

3.1 Imperial German Export Data

I use a newly compiled dataset on Germany's exports which is original both in terms of granularity as well as scope. I refer to Chapter **??** for details on the dataset construction. Products are categorised according to the Standard International Trade Classification (SITC), revision 2, at the five-digit level.[13]

I arrange the data in export spells. Spells are trade relationships reflecting consecutive years during which a particular export flow at the five-digit level was active.[14] For example, when Germany exported steam engines to Italy from 1899 continuously until 1904, this would result in a spell of six years. If beer is exported again to Italy, say, from 1908 to 1913, this would be another, subsequent spell.[15] Table 1 (p. 13) shows an example of how the data looks when arranged in spells. [16]

A typical problem in survival data is censoring: Left-censored spells are spells that started before the start year and therefore at an unknown data and have been active for an unknown duration. Right-censored data are spells that ended after the last year and therefore at an unknown date and, again, with an unknown duration. Another censoring issue is the re-classification of product categories. Over time, categories may be split up or merged. The results from Chapter **??** suggest that such a problem cannot be entirely muted, but because we harmonised the data *ex post*, it is likely to suffer less from re-coding bias than modern trade datasets used in survival analysis.

[13] Classifying thousands of original historical product categories according to a modern standard is non-trivial. See Chapter **??** for details on the product classification.
[14] The total number of five-digit items in the panel is 969.
[15] Note that because I only observe product-level and not firm-level exports, this means that I am forced to ignore potential replacements between different exporters of the same product.
[16] The table is shortened for exposition and is continued in table **??** in the Appendix.

Table 1
Data Example

Country	Years Active	Number of Spells	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Belgium	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
France	24	1		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Austria-Hungary	23	2	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Italy	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Netherlands	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Great Britain	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Portugal	21	3		•	•	•	•	•	•	•	•	•	•		•	•		•	•	•	•	•	•	•	•	•
Spain	22	2		•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•
Switzerland	23	2		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Russian Empire	23	2		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Greece	12	4		•							•		•					•	•	•	•	•	•	•	•	•
Romania	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Bulgaria	12	3							•	•		•						•	•	•	•	•	•	•	•	•
Western Balkans	12	3	•	•	•													•	•	•	•	•	•	•	•	•
British Mediterranean	12	4						•			•		•	•					•	•	•	•	•	•	•	•
Denmark	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Finland	17	1								•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Sweden	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Norway	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
United States	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Canada	22	3	•	•	•	•	•	•		•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•
Mexico	21	3		•	•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•
Argentina	23	1		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Chile	23	1		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Brazil	24	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Peru	21	2			•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Paraguay	5	1																	•	•	•	•	•			
Uruguay	17	4				•	•	•	•	•	•		•			•		•	•	•	•	•	•	•	•	•
Bolivia	10	3								•			•				•	•	•	•	•	•	•	•		
Ecuador	13	4				•				•	•		•					•	•	•	•	•	•	•	•	•
Venezuela	10	4		•					•	•	•						•	•				•	•	•	•	
Colombia	18	5		•		•	•	•	•	•	•	•		•	•	•	•		•			•	•	•	•	•
Costa Rica	6	3		•												•			•	•	•	•				
El Salvador	7	2																	•		•	•	•	•	•	•
Guatemala	12	3		•	•	•							•	•				•	•	•	•	•	•			
Honduras	11	5		•	•		•	•	•				•			•	•	•	•			•				
Nicaragua	8	3			•														•		•	•	•	•	•	•
Panama	11	2			•	•	•												•	•	•	•	•	•	•	•
British West Indies	6	5						•										•		•				•	•	•
[...]																										

A '•' indicates that trade in this particular product category was active, i.e. above zero. Spell data of SITC five-digit item 65613: 'Narrow woven fabrics; narrow fabrics consisting of warp without weft assembled by means of an adhesive (bolducs); other woven fabrics'. This table is shortened for exposition, which is why half of the trade partners are missing in this table. The spells to the countries unreported here are listed in table **??** in the Appendix.

In the present setup, all relationships observed in the first year, 1889, are left-censored. The start year 1889 is not chosen randomly. Before 1889, the two major port cities Hamburg and Bremen were not covered by the German trade statistics (see also Chapter **??**). Although the data has been integrated, the resulting data for the 1880s is unfortunately too patchy for survival analysis. Because of this I exclude all spells that have 1889 as the start year, so that I observe only beginning spells. All relationships still active in the last observed year, 1913, are right-censored as it is unknown exactly how long they are. 1913 is the end year because the statistics end in this year due to the outbreak of World War I.

Figure 1 shows the distribution of export spells on the product level in terms of their length and their value, differentiated by the per capita income of the destination markets.[17] The first impression is that the vast majority of export spells were both short and small in terms of value. Of the almost 90,000 spells I analyse, the mean length was 4.2 years but the median length was merely 2 years: Spell distributions are highly tilted to the right. This means that the latter moment of the distribution is more informative. The median spell value was 12,000 marks and the median initial spell value was worth only 3,000 marks.[18] Moreover, the differentiation between different types of markets with respect to their income exhibits non-negligible variation. Roughly half of all spells went to middle income markets and a quarter went to both high and low income markets, respectively.

Panel 1A considers only spells to high income markets, which comprise most of Germany's traditional trade partners. Spells to these markets were less tightly distributed than spells to middle or low income markets. The median length is 3, and the median spell value is 83,000 marks while the initial size of a spell—i.e. the export value in the first year of a spell—was 10,000 marks.

Panel 1B displays the descriptive statistics for spells to middle income markets. The median spell length here was only 2 years, one year less than spells to rich economies.

[17] See table**??** in the Appendix for a list of countries. Values were winsorised at the 95th percentile.
[18] All these descriptive numbers are based on the entire dataset not differentiated by income and not reported in the histograms of figure 1.

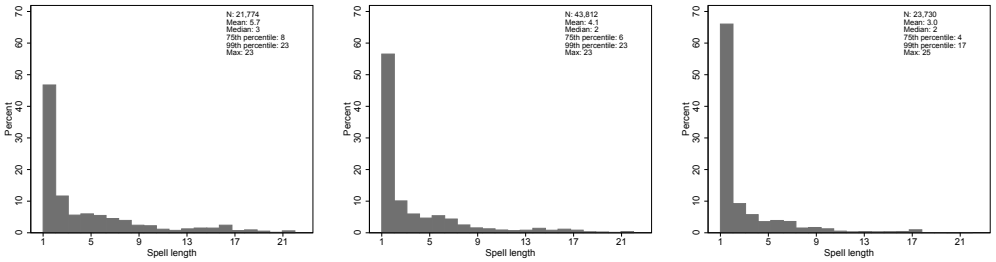
The median spell value was 12,000 marks, i.e. about 14 percent of the median spell value to high income markets. Also the initial median value was only 3,000 marks – a third of the entry values to high income markets.

Panel 1C contains the distributions of spell length, value and entry value for low income markets. The low-income market spells are distributed much more tightly to the left. That is, median spell length to these markets was also only 2 years, but the spells were once again—in parts much—smaller than those to markets with high or middle incomes: The median spell value was 4,000 marks and the median entry value was 2,000 marks.

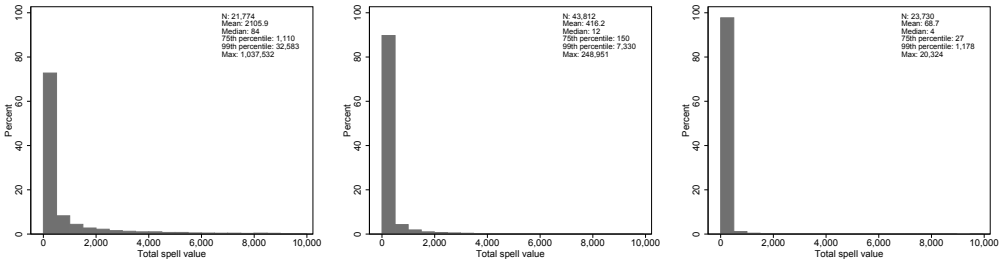
Figure 1
Distribution of Export Spell Length and Value

(A) High Income (B) Middle Income (C) Low Income

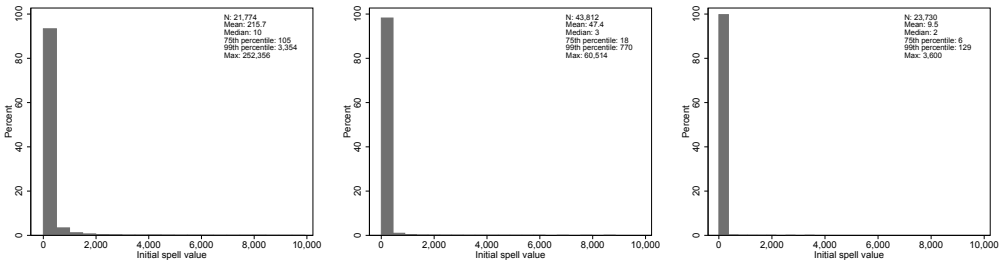
Spell Length



Spell Value



Entry Value



Based on export spells per SITC five-digit good. Values in in 1,000 1913-marks. Spells above 10,000 are not displayed for exposition. Start year is 1889. Table **??** in the Appendix lists the countries according to their income groups. Source: Own calculations.

These distributions point towards a positive association between income levels and longer export spells and spells of greater value. This resonates with the hypotheses outlined above, and the the empirical section below will explore these observations in more detail.

3.2 Covariates

As noted above, reliability and search costs remained undefined in the model of Rauch and Watson (2003). To proxy these rather fuzzy variables, the literature on survival in international trade draws on a set of covariates commonly used in the gravity literature. I do so too. Basic gravity variables come from Fouqin and Hugot (2017), who compiled the most extensive bilateral historical trade dataset so far. They compile proxies for market size such as GDP, population, population density, GDP per capita from various sources, most notably the Maddison project. I add data from Banks and Wilson (2015) where applicable.

Fouqin and Hugot's (2017) dataset also provides the distance between the major ports. Distance proxies transport costs and in the context the hypotheses to be tested, greater distance is expected to raise search costs. To control for effects of the exchange rate regime I thus add gold standard participation of Germany and its trade partners with data from Officer (2008), Reinhart and Rogoff (2015) and Ferguson and Schularick (2006). As noted above, gold standard participation feeds reliability because a fixed exchange rate means less pricing volatility. Whether or not a trade partner had a trade agreement with Germany is controlled for with data from Pahre (2008). Trade agreements aim to reduce the costs of trade through tariff reductions. But they were also often accompanied by improvements in the bureaucratic infrastructure. In the present context that may lead to lower search costs, but also higher reliability. This does not complicate testing hypotheses 3 and 4 separately, because we would expect the same sign on survival (positive).

I also account for the role of cultural similarity. A more similar culture should make it easier to find buyers. Cultural similarity is typically proxied with a language dummy

in the gravity literature. I consider this, however, as less useful for an application that focuses on Germany because there were only few countries with German as an official language. Following Schulze and Wolf (2009), I use a more nuanced measure of cultural proximity based on ethno-linguistic data. I use Lohmann's (2011) index of language similarity, which was specifically calculated for gravity applications on the country level.[19] Colonial status is another standard gravity control for 'culture'. To capture the effects of colonial hegemony, I include a dummy whether or not a trade partner was a colony. Colonial status is more likely to be associated with reliability than with search costs because it essentially captures political risk.

I also consider the activity of both the German government as well as the non-exporting German private sector abroad. At least since the 1890s, German policy makers had export growth on their agenda. For example, the government supported the publication of country reports that then supposed to help exporters to gather market intelligence. Moreover, a growing number of diplomats, mostly special consuls, specialised in the promotion of exports (so-called trade *attachés*). This clearly aimed at lowering search costs.[20] I hand-collected data on the number of trade attachés per country based on diplomats' biographies kept by the German ministry of foreign affairs (Auswärtiges Amt, 2015) to control for Berlin's engagement in export promotion.

Since Gerschenkron (1962) we may also expect that the activity of German banks abroad helped not only industrialisation but also promote exports. Export credit was not yet a financial instrument, nonetheless the presence of German banks is likely to have raised the reliability of a trade relationship to a given market. I implement this conjecture by using data on German bank branches abroad from Battilossi (2006), augmented by data from Hertner (1990) and various bank histories.

Contemporaries were well aware of growing competitive pressure on British merchants by German exporters in foreign markets. Hoffman (1933) coined this the 'German-

[19] I use a population-weighted index for the cases where I aggregated modern countries to historical ones. Because of its finer granularity, the index also allows to incorporate the share of German immigrants in major emigration destinations.

[20] Contemporaries, however, were rather unsatisfied with the support of the government: Information provided by the government were often patchy, outdated at the time of publication or did not meet the exporters intelligence requirements (Weinberger, 1969).

British trade rivalry' (in which Britain was losing according to his account). More British competition is likely to be associated with less reliability because importers can be assumed to switch suppliers more easily when competitiveness was stiffer. To take account of the activity of British exporters in a given market, I extract the aggregate annual imports from Britain by the respective trade partner as well as total imports from Fouqin and Hugot's (2017) dataset, calculate the share of these imports in total imports, and thus obtain a measure of this rivalry in a given market.

4 Empirical Analysis

4.1 Basic Survival

Before addressing the hypotheses derived in Section 2.2, let us consider some basic results on the survival of Germany's exports. The results were obtained from estimations with the Kaplan-Meier product limit estimator that is commonly used in the survival literature (most prominently Besedeš and Prusa, 2006a,b). The estimator yields survival rates, i.e. the fraction of spells that survive a certain number of years, that can be conditioned on categorical covariates.

Figure 2 (page 21) plots the benchmark survival rates (panel 2A) as well as various dimensions of survival in terms of categorical variables that have been introduced in Section 3.2). Table 2 (page 24) contains the details underlying these illustrations.

The first finding visible in panel 2A is what Besedeš and Prusa (2006a) call negative duration dependence. The first years in a market were much more hazardous than the later years. The median spell length was 2 years, only about 60 percent survived the first year, and a mere third of exports lasted longer than 3 years. More than half of all export spells did not survive the first two years. However, once exporters made it through these years, they faced less hazard from year to year. These findings match the survival patterns in modern data: Besedeš and Prusa (2006a), who use SITC five-digit data, on US imports show that only 58 made it beyond the first year and that less than a third of the imports lasted longer than 5 years. Nitsch (2009), who uses

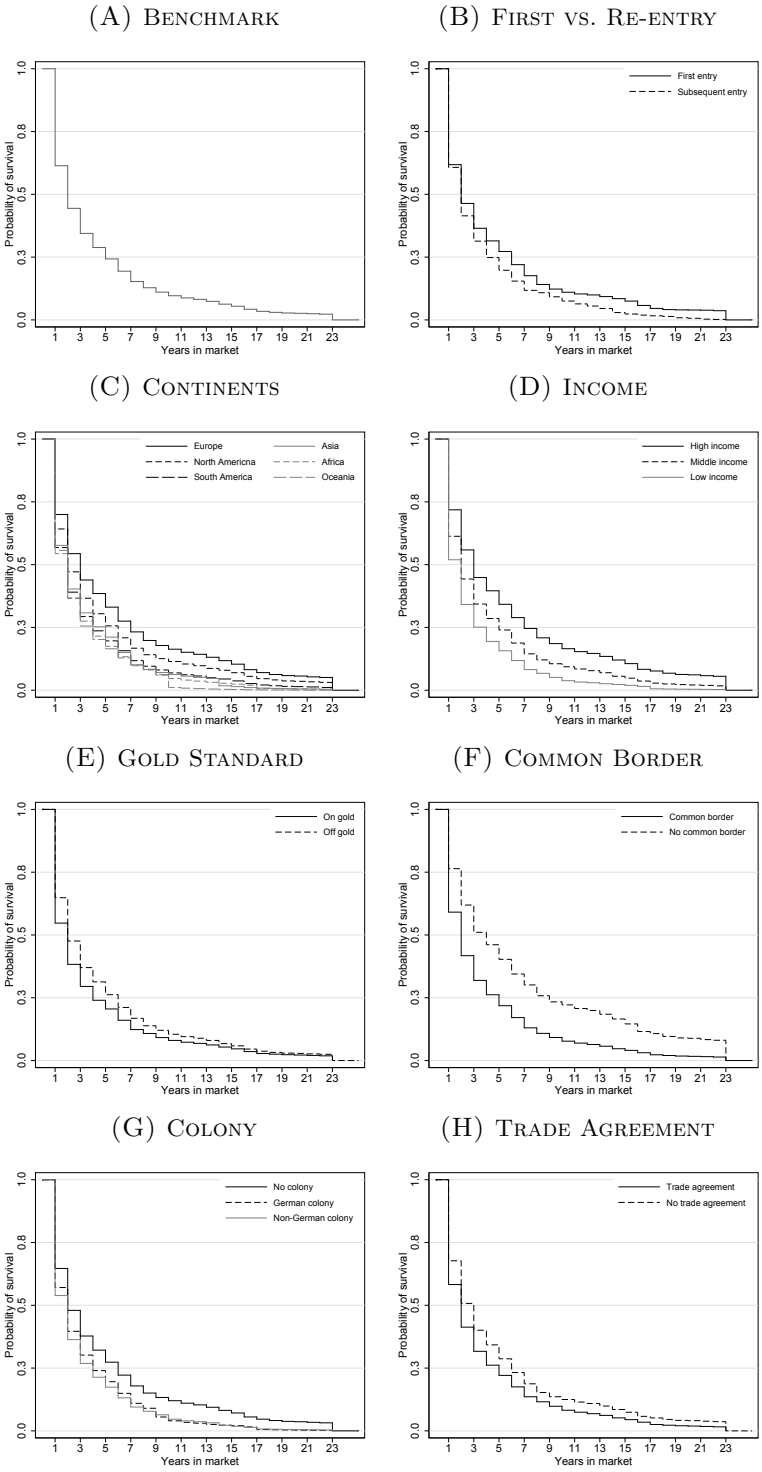
more finely defined product categories but looks at modern German imports, finds 61 percent of German imports survived the first year and less than 40 percent made it to year 5.

Panel 2B differentiates between spells that entered a market for the first time and those that were follow-up spells. First entry spells were longer, but the difference is not too large. Re-entry spells face higher hazard after the first three years and 11 percent of first entry spells lasted longer than 10 years, while only 7.5 percent of re-entry spells did so. This also matches previous findings of Besedeš and Prusa (2006a) and other studies.

Panel 2C considers survival by continent. The graphs show that there comparatively large differences in survival over continents. Given that Europe and North America were generally the richest parts of the the world economy, the survival rates suggest that proximity and market size were positively associated with survival: Exports to Europe and North America exhibit the highest survival probabilities with median lengths of 4 and 3 years, respectively. In Europe, 44 percent of exports survived longer than three years, 16 percent at least 10 years and 6 percent at least 20 years. But also only a third of exports survived longer than 3 years to North America. Exports to all other continents had a median length of merely 2 years. Exports to Oceania were the shortest, where only a quarter of the exports lasted longer than 3 years and almost none made it beyond year 10.

These differences in survival also mirror in the rates displayed in panel 2D, which consider the income groups already used above. Export survival fell with income levels. Exports to high income markets exhibit a median length of 3 years, to elsewhere only 2 years. 34 percent survived at least 5 years to high income markets, but only 16 percent to low income ones. The survival graphs also suggest that there is a stronger effect of income at the long end of the spell distribution: 6 percent of the exports to high income markets lasted at least 20 years, but merely 0.4 percent did so to low income markets.

FIGURE 2
SURVIVAL OVER CATEGORICAL VARIABLES



Based on export spells per SITC five-digit good. See section 3.2 for details on categorical variables. Table **??** in the Appendix lists the countries according to their income groups. Start year is 1889. Source: Own calculations.

Panel 2E shows the differences in survival with respect to gold standard adherence, which proxies the extent to which a stable exchange rate mattered. The results sug-

gest that exports to markets on gold survived longer than those to markets not on gold, particularly so in the first ten years of a spell. 64 percent of the exports survived the first year, but only 54 percent did so to markets off gold.

Panel 2F considers survival in terms of a shared border to Germany. The difference between survival of exports to direct neighbours of Germany and to markets further away is comparatively large. The median length of exports to neighbours was 4 years and thus twice as high as those to non-neighbours. About a fifth of spells to neighbours lasted at least 10 years while only 8 percent survived that long to non-neighbours. This suggests that a common border is likely to have been particularly duration-enhancing.

Panel 2G shows that whether a destination market was a colony or not made only a small difference, albeit survival was higher in non-colonies. 65 percent of the exports to non-colonies survived the first year, while 57 percent did so in German colonies and 53 percent to non-German colonies. The pattern remains over longer spells. This suggests that institutional and language similarity mattered.

Panel 2H shows that having a trade agreement was also positively associated with survival, however, also only to a relatively small extent. 67 percent of the exports made it through the first year under a trade agreement, but only 58 percent did so when there was no trade agreement. We also see a stronger effect at the long end of spell distribution: 4 percent of the exports under a trade agreement lasted at leas 20 years but half of that, 2 percent, did so when there was no trade agreement in place.

Considering the sectoral structure of survival, the results suggest that survival in non-manufacturing (the first four sectors) was lower than in manufacturing (i.e. chemicals, manufactured goods, and miscellaneous manufactured goods). Only exports of machinery and transport (SITC 7) were subject to relatively high hazard. The data also reveals that the largest chunk of exports was—unsurprisingly—coming from chemicals, manufacturing and machinery. However, it turns out that sectors that exported agricultural or bulky goods, such crude materials, generated non-negligible amounts of spells as well with roughly 9 percent of all spells per sector.

The survival patterns discussed above show that there is non-random variation in terms of market characteristics – a variation that is likely to help us understand better *how* Germany's exports went about during the first globalisation. However, in order to explore the hypotheses derived above, and in order to differentiate between the effects of the categorical variables discussed and also other factors that are hard to capture in mere categories, a more thorough analysis follows below.

Table 2
Summary of Survival Rates

	Spells		Length		Survival Probabilities in Year...				
	N	%	Mean	Median	1	3	5	10	20
Total	89,316	100.0	4.2	2.0	61.4	34.4	24.3	9.6	2.6
First entry vs. Re-entry									
First entry	53,866	60.3	4.6	2.0	61.8	36.5	27.2	11.0	3.9
Re-entry	35,450	39.7	3.6	2.0	60.7	31.4	19.8	7.5	0.6
Continents									
Europe	30,489	34.1	5.5	4.0	70.0	43.9	33.1	16.3	5.7
N. America	4,739	5.3	4.5	3.0	64.2	36.6	25.6	11.4	3.5
S. America	21,772	24.4	3.6	2.0	56.8	29.3	19.7	6.9	1.4
Asia	13,600	15.2	3.5	2.0	57.7	30.8	21.1	6.3	0.5
Africa	14,600	16.3	3.2	2.0	54.4	27.5	17.5	4.7	0.5
Oceania	4,116	4.6	3.0	2.0	55.7	25.6	16.5	1.1	0.0
Income Groups									
High	21,774	24.4	5.7	3.0	71.8	44.9	34.2	16.5	6.1
Middle	43,812	49.1	4.1	2.0	61.3	34.3	24.0	9.4	2.1
Low	23,730	26.6	3.0	2.0	52.0	25.1	15.7	3.8	0.4
Gold Standard									
On gold	58,774	65.8	4.4	2.0	64.8	37.0	26.2	10.5	2.9
Off gold	30,542	34.2	3.7	2.0	54.7	29.5	20.5	8.0	2.2
Common Border									
Common border	11,807	13.2	6.7	4.0	76.4	51.1	40.3	22.2	8.9
No border	77,509	86.8	3.8	2.0	59.1	31.9	21.8	7.7	1.7
Colony									
No colony	60,821	68.1	4.6	2.0	64.7	37.8	27.3	12.0	3.6
German colony	4,275	4.8	3.3	2.0	57.1	30.2	19.6	4.0	0.3
Non-Germany colony	24,220	27.1	3.2	2.0	53.9	26.9	17.4	4.6	0.5
Trade Agreement									
Trade agreement	29,486	33.0	4.8	3.0	67.7	40.1	28.7	12.5	4.1
No trade agreement	59,830	67.0	3.9	2.0	58.3	31.7	22.1	8.2	1.9
One-digit Sector									
Food and live animals	8,340	9.3	4.0	2.0	57.5	32.8	23.7	9.7	2.0
Beverages and tobacco	2,298	2.6	4.6	2.0	56.5	36.2	28.2	13.3	2.7
Crude materials	8,781	9.8	4.4	2.0	56.8	32.3	23.0	12.1	4.1
Mineral fuels	1,045	1.2	4.5	2.0	61.4	37.5	24.8	10.9	5.1
Non-mineral oils etc.	1,342	1.5	3.7	2.0	57.0	31.4	22.4	9.2	NA
Chemicals	11,904	13.3	5.0	2.0	61.8	37.0	27.7	14.6	5.5
Manufactured goods	30,922	34.6	4.3	2.0	63.7	36.6	26.1	9.6	2.4
Machinery and transport	9,186	10.3	3.2	2.0	61.7	29.1	17.9	4.3	0.4
Misc. manufactured goods	15,144	17.0	3.9	2.0	62.4	33.5	22.5	7.1	1.7
Other	354	0.4	3.3	1.0	43.8	22.6	16.4	6.2	3.1

N and % refer to the number of spells and their percentage share of all spells. Length refers to the length of spells in years. Kaplan-Maier estimates of survival probabilities in percent for SITC five-digit goods to a given destination. SITC one-digit codes omitted but the ranking of sectors reflects their respective code. Spells from 1889 to 1913. See section 3.2 for details on categorical variables. Table **??** in the Appendix lists the countries according to their income groups. Source: Own calculations.

4.2 Entry Value and Duration (H1)

Recall hypothesis 1: Some exports started small and others large, and large starting flows lasted longer. This hypothesis must be addressed using the value of an export spell in the first year, a difference already made in the distributions presented Section 3.1. Moreover, this hypothesis embodies two sub-questions: Did some trade relationships start small and others large? And: Did large starting flows should last longer? Kaplan-Meier estimations can help answer both questions. The results are reported in table 3.

As noted above, Rauch and Watson (2003) do not specify what small and large exports are. However, given the distributions of spell values presented in figure 1,[21] and for easier interpretation, I categorise export values according to the following adjectives: Values below 1,000 marks are *tiny*, values between 1,000 and 4,999 marks are *small*, values between 5,000 and 9,999 marks may be called *normal*, values between 10,000 and 99,999 marks are *large*, values between 100,000 and 999,999 marks are *huge* and values greater than 999,999 marks are called *exceptional*.

The answer to the first sub-question is yes: There is visible variation in terms of the starting size of an export spell. And this variation turns out to be tilted towards smaller trade flows. 37 percent of exports—the majority of spells—started tiny, i.e. with less than 1,000 marks. The second largest chunk of export spells (26 percent) started with small entry values, i.e. 1,000 to 4,999 marks. 11 percent of spells had normal entry values, i.e. between 5,000 and 9,999 marks. Exceptionally large entry values, on the other hand, made up only 1.3 percent of the spell set. In sum, most exports started tiny, small or normal, while only a small amount of exports started relatively large.

The answer to the second sub-question is yes as well: Exports that started tiny had a median length of 1 year and only 22 percent survived not even the first year. No

[21] Recall that the mean length was 4.2 years but the median length was merely two years, and the median spell value was 12,000 marks and the median initial spell value was worth only 3,000 marks.

such export made it longer than five years. Exports starting with normal sizes exhibit a median length of 3 years. 82 percent survived the first year. Huge and exceptionally large initial export values exhibit the longest duration: 50 percent of spells with initial values above 999,999 marks survived ten years and a fifth even 20 years.

Taken together, the results suggest that most of Germany's exports were small and short, while a minority of exports survived longer and accounted for large values. That is, hypothesis 1 can, thus far, be considered true. Below I decompose these findings further, however, in a Cox-proportional hazard estimation.

4.3 Learning Exports (H2)

Recall hypothesis 2: Some exports were about learning, and these exports ended faster. Like for hypothesis 1, two sub-questions can be derived: How many exports were about learning? And what are the differences in terms of survival? Given that the original Rauch and Watson (2003) model is developed at the firm level, I have to operationalise the concept of learning with the data at hand. We do not know whether an export was intended as an experiment in order to learn or 'just' to generate profits.

Nonetheless it is possible to make a plausible *ex post* definition of learning exports when assuming that these spells were (1) first-time spells, and (2) characterised by

Table 3
Survival Rates by Entry Value

	Spells		Length		Survival Probabilities in Year...				
	N	%	Mean	Median	1	3	5	10	20
< 1,000 M	32,610	36.5	1.3	1.0	22.7	0.8	NA	NA	NA
1,000 to 4,999 M	23,365	26.2	2.4	2.0	65.7	20.5	4.6	0.1	NA
5,000 to 9,999 M	9,753	10.9	4.4	3.0	82.0	49.2	31.0	5.4	0.3
10,000 to 99,999 M	15,585	17.4	7.7	6.0	90.8	68.6	54.7	24.8	6.2
100,000 to 999,999 M	6,844	7.7	10.4	8.0	95.2	77.8	66.1	41.1	15.9
> 999,999 M	1,159	1.3	11.9	11.0	97.2	85.2	74.3	52.5	20.4

Kaplan-Maier estimates for SITC five-digit goods to a given destination. Spell values in 1913-marks ('M'). Start year is 1889. Source: Own calculations.

small or tiny spell values.[22] Below, I consider all first-time export spells with total values of less than 5,000 marks as 'learning exports'. This definition still allows to differentiate between first-time exports to a given market, which I refer to as a 'broad' definition of learning exports. A stricter interpretation of this definition is when only first-time exports independent of the market, i.e. across all markets, are considered. I call this the 'strict' definition of learning. Next to pooled results, I also differentiate exports by destination markets' income because with the above definition of learning and given the previous findings on the distribution of spells, it is likely that more learning took place in middle and low income markets.

Table 4 reports the results, with the upper panel showing the estimates for the broad definition and the lower panel for the strict definition. Consider first the number of learning exports. Under the broad definition, roughly a quarter (26 percent) of all export spells were learning spells. However, a much larger fraction of learning exports occurred in middle and low income markets.

This is different under the strict definition, at least in relative terms, where we see a share of 4 to 5 percent of exports being about learning. In absolute terms, however, middle and low income markets were subject to learning exports about three times as much as high income markets. The results suggest that there were learning exports and they constituted from about 4 percent up to a quarter of all exports, depending on the definition.

Addressing the second part of hypothesis 2, the results suggest that learning exports were much shorter. Under both definitions, about only a third of the export spells lasted longer than 1 year, and none made it longer than 10 years. Only 1 to 2 percent of the learning exports survived until year 5 in the foreign market. This pattern holds across the different income categories. Taken together, these findings suggest that hypothesis 2 can be considered true: Some exports were about learning, and they were much shorter than non-learning exports.

[22] Note that this is different to hypothesis 1, where I consider only entry values.

Table 4
Survival Rates of Learning vs. Non-learning Exports

		Spells		Length		Survival Probabilities in Year...				
		N	%	Mean	Median	1	3	5	10	20
Broad definition of learning										
Pooled	Non-learning	66,244	74.2	5.1	3.0	72.6	44.7	32.2	12.9	3.5
	Learning	23,072	25.8	1.5	1.0	29.1	4.8	1.1	0.0	NA
High income	Non-learning	18,485	84.9	6.4	4.0	79.1	51.9	39.6	19.3	7.2
	Learning	3,289	15.1	1.5	1.0	30.3	4.1	1.2	NA	NA
Middle income	Non-learning	32,944	75.2	4.9	3.0	71.9	44.2	31.7	12.4	2.8
	Learning	10,868	24.8	1.5	1.0	29.1	4.7	1.0	0.0	NA
Low income	Non-learning	14,815	62.4	3.9	2.0	66.1	37.1	24.4	6.1	0.6
	Learning	8,915	37.6	1.5	1.0	28.6	5.2	1.3	0.0	NA
Strict definition of learning										
Pooled	Non-learning	85,241	95.4	4.3	2.0	62.8	36.0	25.4	10.1	2.8
	Learning	4,075	4.6	1.6	1.0	32.3	4.6	1.4	NA	NA
High income	Non-learning	20,847	95.7	5.9	3.0	73.6	46.8	35.5	17.2	6.4
	Learning	927	4.3	1.6	1.0	33.1	4.7	1.1	NA	NA
Middle income	Non-learning	41,810	95.4	4.2	2.0	62.7	35.9	25.2	9.8	2.2
	Learning	2,002	4.6	1.6	1.0	33.3	5.3	1.3	NA	NA
Low income	Non-learning	22,584	95.2	3.1	2.0	53.1	26.1	16.4	4.0	0.4
	Learning	1,146	4.8	1.5	1.0	29.8	3.4	1.8	NA	NA

Kaplan-Maier estimates for SITC five-digit goods to a given destination. Start year is 1889. Table **??** in the Appendix lists the countries according to their income groups. Source: Own calculations.

4.4 Reliability, Search Costs and Duration (H3 and H4)

The above results rely on the Kaplan-Meier estimator which yields survival rates. However, such analysis forbids to consider non-categorical covariates. But the latter matter for the remaining two hypotheses, which will be considered together below. Moreover, I am able to illuminate the role of learning exports (H2) further. Recall hypothesis 3: The more reliable the importer was, the longer the duration, and hypothesis 4: The lower the search cost were, the longer the duration. Since reliability and search costs have to be approximated, I interpret the results as discussed in Section 3.2.

I follow the studies on survival of modern trade flows (Besedeš and Prusa, 2006a,b; Besedeš, 2008) and estimate a panel proportional hazards model

$$H = (t, X, \beta) = H_0(t) \exp\left(X'\beta + \gamma_t\right), \tag{1}$$

where X is a vector of covariates , β is the vector of coefficients to be estimated, and γ_t denotes time fixed effects.[23] The baseline hazard $H_0(t)$ captures how hazard changes as a function of time and with respect to the respective covariates.[24]

I follow Weidenmier and Mitchener's (2008) gravity application in using population as my preferred proxy for market size because this allows covering a larger sample due to the fact that population data is more widely available also smaller and less developed economies. The appendix also contains results based on GDP and I highlight the differences when illuminating.[25]

Next to the gravity variables introduced in Section 3.2, I add multiple further variables: Given that Section 4.2 has shown that the initial entry value matters, I include the latter to set of covariates. Higher entry values should raise the chances of survival. I also include multiple dummies. Learn equals one if the spell in question was a (s)trictly or (b)roadly defined learning spell as in Section 4.3. Learning spells should be subject to higher hazard than non-learning spells. Re-entry equals one if the spell in question was a re-entry. Besedeš and Prusa (2006b) argue that re-entries may make a second failure more likely (higher hazard), but re-entries may also mean that the return of an exporter to the market is a positive sign making a second failure less likely.

Moreover, I generate a set of continuous covariates that I call experience ('Exp.'). Experience is the cumulative number of learning spells until one year ahead of the beginning of a spell, again once (s)trictly and once (b)roadly defined. This export experience is collected per industry, i.e. at the three-digit level. This allows capturing

[23] I ran a number of other specifications of equation 1 using different types of fixed effects (time-sector, time-product, etc.) as well as specifications in which I merged spells that were separated by only one year, which is a typical robustness check in the survival literature: Due to erroneous misreporting a true spell may actually consist of two subsequent spells. However, by and large, the estimations turned out very similar so that I refrain from reporting them. All estimation results are available on request.

[24] Brenton *et al.* (2010) criticise the assumption of proportional hazards that is needed for Cox regressions to be valid. For a full discussion of the drawbacks of Cox regressions in the context of trade data and alternative estimators, see Hess and Persson (2012).

[25] I also played around with population density instead of population as well as a combination of both area and population, but the results turned out very similar to what is presented below. The results are, however, available upon request.

within-industry learning spillovers that both the qualitative and quantitative literature cited in Section 2.

One version of the variable ('Reg. Exp.') includes experience that is regional.[26] Defining experience in this way honours findings on spatial and sequential exporting, i.e. that exporters tend go to markets that are similar and close to previous export destinations (Albornoz *et al.*, 2012; Defever *et al.*, 2015). When this variable is included, the respective set of learning spells are excluded. I also include another version of experience, 'Reg. ML', that collects the number of previous learning spells per industry in middle and low income economies. The idea is that although exports to these markets made up only about a fifth of export value, experience in these markets may be particularly valuable because survival in these less developed, often further away and culturally more distance markets was tougher – which means that there was more to 'learn' than in traditionally served markets. To rule out simultaneity and to strengthen the role of possible spillovers, I always exclude the product-specific experience in all of these experience measures. That is, for example, when I estimate that survival of mens' shoes, only experience of exporting other than mens' shoes is drawn upon. The distributions of this experience show which sectors gathered most experience: chemicals, machinery, manufacturing and consumer goods. The sectors of Germany's alleged comparative advantage.[27]

What is more, I always report results for the whole set of markets and only high income destinations. I do so because, on average, 79 percent of Germany's export value was absorbed by such markets, and this way of estimation survival probabilities allows to infer the role of learning exports, which—as shown above—primarily went to middle and low income economies, for trade in more traditional markets.

The estimates are reported as hazard ratios. An estimated hazard ratio less than 1 is interpreted as implying the variable lowers the hazard rate, and vice versa. A ratio equal to 1 implies no impact on the hazard rate. That is, for example, if the hazard

[26] See table **??** in the Appendix for a list of regions.
[27] Appendix **??** contains distributions of this variable by one-digit sector.

ratio is 0.95, a one-unit change in the covariate is associated to a 5 percent higher survival probability.

Table 5 (p. 32) reports the benchmark results for all markets. Let us consider search costs (H3) first. Raising distance by 1,000 kilometres is associated with roughly 2 to 4 percent higher hazard. Language similarity as a proxy for cultural similarity is associated to much lower hazard, that is by about 20 percent.[28] The presence specialised consuls is also associated with lower hazard, but only to a very small extent. Moreover, the results of distance as well as the presence of consuls do not only exhibit high statistical significance. Using GDP instead of population yields somewhat weaker border and language effects (table **??** in the Appendix). Taken together, these results suggest that lower search costs did indeed improve matching and thus survival. In other words, hypothesis 3 holds, primarily though through the culture channel.

Let us turn to reliability (H4). Market size turns out be associated with improvements of survival. Raising population by one million means that hazard rates fall about 7 percent. Using GDP instead of population yields stronger survival effects of GDP (table **??** in the Appendix). Similarly, a fixed exchange rate was associated with higher survival. Being on gold lowers hazard by about 5 percent. Colonies were more hazardous: Hazard is about 2 to 3 percent higher there. Trade agreements are mildly positively associated with higher survival. The presence of German banks as well as British competitors, however, is statistically insignificant. That is, higher reliability seems to have improved survival, primarily through market size and the exchange rate.

Learning spells as defined in the assessment of hypothesis 2 are extremely hazardous. If an export is experimental, the probability that it fails is more than twice as high than non-learning spells, even if we only use the strict definition of learning spells. This underlines hypothesis 2: Learning was more hazardous.

[28] The unit of this variable is percent.

The results also support hypothesis 1: Higher entry values of a spell lowered hazard by about 2 to 3 percent. Re-entries, on the hand, are subject to higher hazard.

Consider now the different measures of export experience (columns 3 to 6). Previous industry experience in the region of the destination market is associated to about 5 percent higher survival. Moreover, previous experience of an industry in markets other than high income markets lowered hazard by roughly 9 percent, depending on the definition. Adding these variables also lowers the sizes of the effects as well as the statistical significance of many other variables. This suggests that the more experience an industry had in exporting, the less important classic frictions to trade were.

Table 6 reports the results for high income destinations only. Search costs as proxied by distance turn out to be statistically insignificant now. This is plausible given Germany's central position in Europe and close proximity to many high income markets

Table 5
Cox Proportional Hazard Estimates: All Markets

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Distance	1.036***	1.032***	1.035***	1.028*	1.008**	1.008*
Population	0.925*	0.926*	0.924*	0.936**	0.933**	0.934*
Border	0.849***	0.832***	0.860***	0.853***	0.876***	0.875***
Colony	1.035***	1.029***	1.018*	1.020*	1.015***	1.004**
Gold	0.948***	0.962***	0.950***	0.952***	0.944***	0.949***
Trade agr.	0.993*	0.992*	0.981	0.983**	0.995*	0.993**
Consuls	0.996**	0.998*	0.997*	0.995***	0.995**	0.995**
Language sim.	0.795***	0.769***	0.778***	0.776***	0.797***	0.801***
German banks	1.004	1.005*	1.003	1.000	1.003	0.999
UK mkt. share	1.000	1.000	1.000	1.000	1.000	1.000
Entry value	0.971***	0.989***	0.970***	0.990***	0.970***	0.990***
Learn (s)	2.434***					
Learn (b)		3.242***				
Reg. Exp. (s)			0.948			
Reg. Exp. (b)				0.949***		
Exp. ML (s)					0.935***	
Exp. ML (b)						0.925***
Re-entry	1.382***	1.433***	1.572***	1.290***	1.253***	1.293***
N	75,680	75,680	75,680	75,680	75,680	75,680

Dependent variable: Hazard ratios of export spells at SITC five-digit good to a given destination. Cox proportional hazard estimations as in equation 1. Start year is 1889. Year fixed effects included but not reported. N refers to the number of spells. Significance: * 10 percent, ** 5 percent, *** 1 percent. Table **??** in the Appendix lists the countries according to their income groups. Source: Own calculations.

in its direct neighbourhood.[29] Language similarity remains statistically significant, but with slightly weaker positive effects on survival than in the full sample. The same holds, more pronounced, for the presence of specialised consuls.

However, when using GDP instead of population stronger survival effects of distance occur as well as much stronger language similarity effects occur (table **??** in the Appendix). That is, search costs also seem to have mattered in survival in high income export markets, in slightly different fashions.

Considering reliability once again, we see that market size continues to improve survival, which suggests that reliability is associated with higher survival. However, the effect sizes are smaller for high income destination markets. The effect of colonial status, in contrast, is stronger for these markets, but this is likely due to the fact that Hong Kong is the only colony in the high income sub-sample – so here the colony dummy is may be interpreted as a Hong Kong dummy. Gold standard adherence is also positively associated with survival, but more weakly so both in terms of economic and statistical significance. Once again, the presence of German banks is insignificant, while British competition now has a statistically significant effect in most specifications – however, a positive one: More competition from British exporters in high income economies is associated with higher survival of German exports. This suggests that German exporters actually seem to have benefited from more competition. Trade agreements exhibit a stronger effect on survival, which points to a more important role of trade policy with developed economies. In sum, also reliability continues to matter for export survival in high income economies only, but less so than in the full set of markets.

The results for rich economies confirm, on the other hand. strongly the role high entry values (H1) and the high failure probability of learning spells (H2). Turning to

[29] In their account of Japan's export growth during the first globalisation, Meissner and Tang (2017) find somewhat stronger distance effects in their logit estimations of market entry. These remain, however, in the same ballpark as the results of this paper. And they are plausible given Japan's more isolated geographic location.

Table 6
Cox Proportional Hazard Estimates: High Income Markets Only

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Distance	1.001	1.001	1.000	1.000	1.000	1.000
Population	0.973***	0.976***	0.975**	0.981**	0.993**	0.994*
Border	0.902***	0.901***	0.927**	0.929**	0.956***	0.955***
Colony	1.215***	1.204***	1.212***	1.232***	1.035***	1.024**
Gold	0.971*	0.996*	0.965*	0.956*	0.944*	0.949*
Trade agr.	0.907***	0.901***	0.926**	0.941**	0.985*	0.983***
Consuls	0.987***	0.987***	0.982*	0.981*	0.995	0.995
Language sim.	0.837***	0.837***	0.897***	0.868***	0.807***	0.801***
German banks	1.003	1.002	1.001	0.999	1.003	0.999
UK mkt. share	0.996***	0.996***	0.996***	0.996***	1.000	1.000
Entry value	0.971***	0.987***	0.971***	0.988***	0.970***	0.990***
Learn (s)	3.188***					
Learn (b)		3.502***				
Reg. Exp. (s)			0.972*			
Reg. Exp. (b)				0.951***		
Exp. ML (s)					0.979***	
Exp. ML (b)						0.973***
Re-entry	1.273***	1.273***	1.179***	1.181***	1.213***	1.202***
N	20,079	20,079	20,079	20,079	20,079	20,079

Dependent variable: Hazard ratios of export spells at SITC five-digit good to a given destination. Cox proportional hazard estimations as in equation 1. Start year is 1889. Year fixed effects included but not reported. N refers to the number of spells. Significance: * 10 percent, ** 5 percent, *** 1 percent. Table **??** in the Appendix lists the countries according to their income groups. Source: Own calculations.

the measures of export experience (columns 3 to 6), it turns out that, by any definition, experience is economically and statistically associated with higher survival. Moreover, as above, the effect size of the other variables often falls when adding experience. The most interesting result in this context is that experience gathered in markets with middle or low incomes lowers hazard of exports to high income economies (column 6). This means that all the tiny and small, highly hazardous learning exports were worth not necessarily higher turnover, but they gave exporters knowledge that helped them survive in their traditional markets.

In summary, the findings above confirm, by and large, the hypotheses derived from the Rauch and Watson (2003) model: Many exports ended quickly, and a part of the exports German exporters made seem to have been more about learning than about 'making money' – German exporters 'started small' when the 'environment was unfa-

miliar'.[30] German export survival during the first globalisation depended on reliability and search costs, but less so in developed markets and less so, when an industry was able to gather more experience abroad prior to a new export.

We may infer that export experience was subject to sectoral spillovers. If not, the short duration and the often very small value of export spells would be at odds with the fact that exporters had to overcome market entry costs every time they entered a market, as studies focusing on the extensive margin of international trade suggest.[31] That is, knowledge about and skills on how to export can be—at least in parts—assumed to have been public so that other exporters or multi-product exporters were able to spread their market entry costs over various spells. Indeed this helps rationalise the finding that export experience seems to have mitigated some of the negative impact of search costs and lower reliability.

More broadly, these findings resonate well with the qualitative historiography on German exporting in the first globalisation: The measures of experience developed above are a quantification of what this earlier literature has laid out in greatly detailed anecdotal evidence: German exporters learned to adapt to foreign market conditions, which in turn allowed them to excel abroad. This process may be characterised as cumulative, the more an industry knew about exporting the more successfully it was at exporting. The findings are also corroborating evidence on the literature that highlights various dimensions of uncertainty in international trade. The phenomena of learning exports may be interpreted as 'trial-and-error' which led to the build-up of export know-how during a process of '(self-)discovery'. This knowledge was then successfully used in subsequent exports. Put differently, learning to export was a salient feature of Germany's experience in the first globalisation.

[30] This borrows from the title of Rauch and Watson (2003): 'Starting small in an unfamiliar environment'.
[31] Besedeš and Prusa (2011) make a similar argument.

5 Conclusion

This paper illuminates a previously unexplored, but important dimension of Germany's rapid export growth during the first globalisation: The survival margin. A decomposition of Germany's exports from 1889 to 1913 into export spells on the product level allows to uncover what happens between market entry and exit. I find that the first years of an export were the most hazardous. The median length of an export spell was 2 years, only about 60 percent survived the first year, and a mere third of exports lasted longer than 3 years. However, once exporters survived the first two years they face less hazard from year to year.

Rauch and Watson's (2003) search cost model of trade relationships is drawn upon to derive hypotheses that I test in order shed more light on the duration of Germany's exports. One of the key features of this model is that a fraction of exports serve to learn about market conditions. I quantify this learning, and find that up to a quarter of Germany's exports may considered as 'experimental' – exporters were learning about the market conditions abroad. My findings suggest that search costs as well as reliability turn out to have been important for export survival, but that export experience is likely to have mitigated both to a certain extent. That is, I suggest a way to quantify how German exporters learned to adapt to foreign market conditions. This resonates well with earlier qualitative accounts of Germany's growing engagement in exporting and with recent insights from the trade literature that emphasizes various dimensions of uncertainty during as well as experience from exporting.

The traditional Heckscher-Ohlin narrative of the first globalisation struggles with this part of Germany's globalisation experience. But the results presented here constitute corroborating evidence that many of the features we find in disaggregated historical trade data are not merely noise, but that they constitute essential parts of the mosaic of international trade. They are a symptom of micro level trade dynamics that yield the aggregate phenomena much of the previous economic history of globalisation has been analysing.

Of course, the evidence presented here is, by and large, correlational; no claims for causality are made. Nevertheless, the stylised facts that emerged may help us understand better why Germany experienced the strong export growth that occupied the minds of many contemporaries and that is likely to have set the base for Germany's role as one of the major export economies today – a claim that obviously has to be substantiated. That is, there are manifold avenues for further research.

Future research could be to link what German exporters did during the first globalisation to today's globalisation. Batteries of anecdotal evidence as well as individual business histories suggest that we should expect strong path dependency in the extent and ways exporters cater to foreign markets. Path dependency here would mean that German exporters managed to stay in foreign markets despite two world wars and a global economic depression in between.

Measures of export experience could also be implemented in a more thorough causal analysis in order to find out when and where exporters were particularly successful in gathering valuable export experience in contrast to mere failures. Moreover, the insights on export survival and export experience could be integrated and tested more formally with what happens at the extensive and intensive margin, say in a framework related to that of Helpman *et al.* (2008) or Besedeš and Prusa (2011). That is, how much experience mattered for market entry and higher trade values remains an open question.

Finally, it would be worthwhile to consider whether the export patterns that are salient to Germany's globalisation were a German peculiarity. Future research may tackle this issue since researchers around the world are currently gathering similarly granular datasets on the first globalisation.

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Appendix