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Competition Policy and Exit Rates: Evidence from Switzerland

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Abstract

This paper provides evidence on the relation between the intensity of product-market competition and the probability of exit. We adopt a natural experiment approach to analyze the impact of a tightening of Swiss antitrust legislation on exit probabilities. Based on a sample of more than 68,000 firms from all major sectors of the Swiss economy, we find that the exit probability of non-exporting firms increased significantly, whereas the exit probability of exporting firms remained largely unaffected. Our results support the notion that there is a positive relationship between the intensity of product-market competition and the probability of exit.

KEYWORDS: competition intensity, exit, natural experiment

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1 Introduction

There is broad consensus that consumers typically benefit from the enforcement of antitrust laws. However, it is less clear whether producers actually suffer from the reduced opportunity to increase profits by collusion. For instance, Selten (1984) shows that, under free entry and exit, cartel laws prohibiting collusion are not necessarily bad for business: When collusion is effectively prevented, there are fewer competitors, and active producers make higher profits on average than when they collude.[1]

More recent work by Sutton (1991, 1998) also emphasizes that the equilibrium number of firms tends to decrease when the intensity of product-market competition increases. In particular, Sutton's analysis demonstrates that there is a robust relation between the intensity of product-market competition and concentration in industries where sunk costs are *exogenous*: There is a lower bound to concentration that unambiguously increases with the intensity of product-market competition. That is, the higher the intensity of product-market competition, the lower the equilibrium number of firms that may be supported by this market. The picture is less clear, however, for industries with *endogenous* sunk costs; that is, firms bear significant costs for advertising or research and development (R&D) before competing in the product market. In this case, the effect of more intense product-market competition on concentration can go either way.[2]

It is probably fair to say that the empirical evidence on the relation of product-market competition and concentration is rather scant and has produced mixed results (see Elliot and Gribbin 1977, O'Brien et al. 1979, and Bittlingmayer 1985). The lack of clear evidence is unsurprising, given the difficulties associated with measuring the intensity of product-market competition and handling the notorious endogeneity problems in industry studies. In a recent analysis of the impact of antitrust policy on concentration in the U.K., Symeonidis (2000b) has circumvented these problems by adopting a "natural experiment" framework, viewing the introduction of cartel policy as an exogenous event.[3] His results support the notion that more intense product-market competition increases concentration in both exogenous and endogenous sunk-cost industries.

[1] See Phlips (1995, Ch. 3) for a textbook discussion of Selten's argument.

[2] Symeonidis (2000a, Property 1) illustrates this ambiguity in the setting of a linear Cournot model with quality indices, where concentration is likely to decrease (increase) in the neighborhood of perfect collusion (the non-collusive Nash equilibrium, respectively).

[3] See Meyer (1995) on the use of natural and quasi-experiments in economics.

In the present paper, we focus on a closely related question that has largely been ignored in the previous literature: How does an (exogenous) increase in the intensity of competition affect a firm's *exit probability*? We think this is a natural question to ask, as one might expect exits to increase—at least temporarily—when product-market competition becomes more intense. Also, taking the perspective of an individual firm allows us to sidestep the nontrivial problem of constructing useful concentration measures across a large number of diverse industries.[4]

Following Symeonidis (2000b), we adopt a natural-experiment approach to analyze the impact of a major change in Swiss antitrust law in July 1996 on exit probabilities. More specifically, we compare the impact on the "treatment group" of non-exporting firms facing little competition in domestic markets with the impact on a "control group" of exporting firms operating under international competition. In doing so, we exploit the *dualistic* nature of the Swiss economy with competitive export industries and highly cartelized domestic industries (see Borner et al. 1995).[5]

Earlier work by Klepper and Graddy (1990), Agarwal and Gort (1996), and Van Kranenburg et al. (2002) suggests that a firm's exit probability should depend on firm-specific characteristics—such as a firm's size, age, location, and so on—as well as on industry-specific and macroeconomic conditions. To our knowledge, Van Kranenburg et al. (2002) is the only paper that has analyzed the relationship between the intensity of product-market competition and exit rates. These authors use the (lagged) number of competitors in the daily newspaper industry under consideration as a proxy for the intensity of product-market competition, and they find that exit rates tend to increase with the intensity of competition.

From the perspective of the literature discussed above, the number of competitors in any given industry is likely to be a good proxy for the intensity of product-market competition only if the number of firms may be treated as an exogenous variable; that is, if it is safe to assume that firms cannot decide about entry or exit. In contrast, if the number of firms

[4]For instance, the well-known m-firm concentration ratio, which adds up the m highest market shares in the industry (see, e.g., Tirole 1988, 221), will not react to liquidations or mergers of smaller firms.

[5]It would be desirable to adopt a similar approach to analyze the effect on *entry*. However, such an analysis is possible only for prespecified categories (such as industries or regions), and not at the firm level, since firms are inexistent before entry. Yet, it is very difficult to classify specific categories as exporting or non-exporting, since there are non-negligible numbers of exporting and non-exporting firms in each category (see Table 1). Furthermore, we are not aware of sufficient data on entry in Switzerland.

is endogenous, a high intensity of product-market competition is associated with a small equilibrium number of firms, as only a small number of firms may be supported by the profits available in this market. That is, relative to the case where the number of firms is exogenous, the chain of causation between the number of firms and the intensity of downstream competition is reversed. In particular, we should expect that the intensity of product-market competition is high (rather than low) when the number of firms is small. With this in mind, we think that it is natural to view the number of firms as being endogenous in a study of firms exiting the market.

For this study, we use a large combined data set that has become available only recently. Part of the data comes from the Swiss Business Census, which is a complete inventory count encompassing approximately 297,000 firms. This census contains information on the characteristics of active firms at the time of the inventory count (in September 1995), including their age, location, legal form, number of employees, and export share. The data on the firms' exits were provided by Dun & Bradstreet, which has compiled a comprehensive database covering three different types of exits: (i) bankruptcy, (ii) voluntary liquidations, and (iii) mergers.

Employing a Cox (1972, 1975) model with time-varying covariates, we obtain the following main results. *First*, the tightening of Swiss antitrust legislation in 1996 had a strong temporary impact on firm conduct, raising hazard rates for the full sample significantly. *Second*, whereas non-exporting firms experienced a significant increase in hazard rates, exporting firms already exposed to international competition were not significantly affected by the change in antitrust legislation. The significant temporary increase in exit rates supports the notion that the tightening of antitrust legislation in July 1996 led to an increase in the intensity of competition within Switzerland. *Third*, our findings with respect to the remaining determinants of hazard rates—firm- and industry-specific properties as well as macroeconomic conditions—are in line with previous literature. In particular, we find that hazard rates tend to decrease in age and size.

The remainder of the paper is organized as follows. Section 2 provides a brief discussion of the change in antitrust policy in Switzerland. Section 3 describes the data set and variables. Section 4 sets out the empirical model and discusses our main results. Section 5 concludes.

2 The Change in Swiss Antitrust Policy

Traditionally, Swiss antitrust policy was perceived as being very permissive (see, e.g., Porter 1990, 714). In part, the lax attitude of Swiss antitrust authorities towards anticompetitive conduct can be explained by the fact that the Swiss constitution makes it difficult to declare cartels unlawful. Before the revision of Swiss antitrust law in 1996, antitrust authorities were required to go through a rather opaque process called the "balance method" (Saldomethode) to evaluate the costs and benefits of a particular (mis)conduct, with considerations such as the impact on the labor market of specific regions routinely playing an important role. Since it generally was very difficult to prove that a cartel actually had a negative "net benefit", cartels were rarely prohibited. Neven and Ungern-Sternberg (1997, 36) describe the performance of Swiss competition policy up to the mid 1990s as follows:

> "In the past, the [Cartel] Commission has relied far too much on judgements and far too little on sound analysis. In various dimensions (definition of relevant markets, evaluation of dominance, evaluation of countervailing benefits, imposition of remedies), the analysis is rather poor by the standards of other jurisdictions. It lacks organising principles, fails to bring appropriate evidence and often relies on highly judgmental evaluations."

Emphasizing the need for a thorough revision of Swiss antitrust law, Borner et al. (1995) further pointed out that the Swiss economy featured *dualistic characteristics*: On the one hand, there was the competitive export sector serving world markets; on the other hand, there was a highly subsidized domestic sector facing little competition due to a mixture of public regulations and collusion.

The revision of the antitrust law analyzed in this paper was implemented on July 1, 1996. It finally led to the prohibition of so-called "hard" cartels that eliminate "effective competition" by fixing prices, restricting quantity, or dividing up markets (Art. 7). Furthermore, the balance method was abolished. These improvements were expected to considerably intensify competition in domestic markets, even though there arguably remained a number of relevant shortcomings—the competition authorities lacked the power to penalize offenders without delay and to confiscate extra profits

from unlawful behavior (OECD 2000).[6]

This rather drastic change in Swiss antitrust legislation allows us to study the effect of intensifying product-market competition on firms' exit behavior using a natural-experiment framework: The change in antitrust legislation generated variation in the intensity of product-market competition that is plausibly exogenous (Meyer 1995). We can thus sidestep the well-known endogeneity problem of structure and performance studies (Schmalensee 1989).

To evaluate the impact of the change in antitrust law on firms' exit behavior, we rely on the dichotomy of the Swiss economy and distinguish two types of firms:

- The vast majority of Swiss firms was active solely in domestic markets; that is, they did not export to foreign countries ("*non-exporting firms*"). These firms should have been significantly affected by the change in antitrust legislation.

- A smaller, albeit relevant, number of Swiss firms exported at least part of their output to the world market ("*exporting firms*"). The impact of the change in Swiss antitrust law on these firms should have been smaller, as they already faced intense competition in international markets. In particular, it is reasonable to hypothesize that exporting firms were not significantly affected by the change in Swiss antitrust legislation.

3 Data and Variables

In this section, we briefly discuss our data and the variables used to estimate the impact of the change in antitrust law on firms' exit probabilities.

3.1 Data Source and Sample Composition

For the purpose of this study, we merged the following databases:

(i) *Swiss Business Census* (SBC 95). The SBC 95 is a complete inventory count compiled by the Swiss Federal Statistical Office (BFS), which contains all firms with more than 20 weekly aggregate working hours

[6]Eliminating these and other shortcomings was the objective of yet another revision of the antitrust law enacted in April 2004.

existing in September 1995, excluding the agricultural sector. The SBC 95 provides numerous variables that characterize the attributes of these firms (as of September 1995).

(ii) *Dun & Bradstreet Exit Database* (DBED). The DBED contains all exits of firms registered in Switzerland from January 1994 to December 2000. It distinguishes the following types of exit: (i) bankruptcies, (ii) voluntary liquidations, and (iii) mergers.

The merged database covers an observation period from October 1995 to December 2000. After deleting all firms that were non-profit oriented according to their legal status—such as cooperatives ("Genossenschaften"), associations and clubs ("Vereine"), foundations ("Stiftungen"), churches, embassies and international organizations—the merged database contained 276,123 firms. Since for sole proprietorships, the DBED does not fully cover voluntary liquidations and mergers, we dropped all sole proprietorships. Furthermore, we dropped all firms established prior to 1970, since no information on their founding dates was available.

After dropping these firms, our sample is still comprehensive and includes more than 70,000 firms. In particular, we have firms of all sizes that have been in business from one to 25 years in our data set, which rarely has been the case in previous studies. In addition, with the exception of the agricultural sector, our sample contains all industries represented in Switzerland (including services), whereas earlier work typically focused on only a few industries and did not cover services due to data limitations.

However, we are aware of two disadvantages of our database, both of which are associated with the way entries and exits were recorded. First, whereas the DBED records exit times as exact dates (day/month/year), the SBC 95 gives entry dates in intervals only (various time spans).[7] One approach towards dealing with this problem in survival analysis is the use of interval-censored models. However, these models are not designed to handle time-varying covariates (changes within the intervals), which will be crucial for our analysis below. We therefore adopted the alternative approach of assuming a uniform distribution of entries within these intervals (since no further information was available) and simulating the date of entry, which yielded survival times measured in quarters. Second, it is well-known that firms tend to announce voluntary liquidations with some delay (i.e., after

[7]Entries were recorded in the following nine intervals (..., 1969], [1970,1980], [1981,1985], [1986,1990], [1991], [1992], [1993], [1994], [1995].

closing down operations), giving rise to delays in registration. This is an inherent problem of business failures studies.

It is instructive to compare the composition of our sample with that of a related study by Harhoff et al. (1998) for West Germany, which is similar to ours in a number of respects: First, it contains manufacturing as well as service firms, unlike the vast majority of other studies. Second, these authors observe bankruptcies and voluntary liquidations. Third, they have older firms in the sample that were at risk before the survey period ("delayed entry"). Finally, their observation period is of a similar length as ours.[8]

We now highlight some special properties of our sample. The descriptive statistics given in Table 1 indicate that small firms make up a large proportion of Swiss firms: Using the number of employees (*Emp*) to measure firm size, the average size of non-exporting firms is about 10 employees, whereas the average size of exporting firms is about 14 employees.

Recall from our above discussion that firms founded before 1970 had to be excluded from our sample due to data limitations. It is thus unsurprising that, on average, firms were only about 8 years old when they entered the survey period, whereas they were roughly 29 years old in Harhoff et al. The firms in our sample are thus relatively young.

We further find that, after excluding sole proprietorships, stock corporations clearly dominate in our sample, with close to 80 percent of all firms belonging to this group.[9] This share looks surprisingly large compared to Harhoff et al., where only about 4 percent of the firms are stock companies. However, the difference may be explained by our exclusion of sole proprietorships and the fact that Swiss legislation makes the stock corporation an attractive legal form even for small firms.

Finally, taking a look at industries, we observe that more than two-thirds of the firms in our sample belong to the service sector (in the SBC 95 this share amounts to three-quarters of all firms). The vast majority of previous studies had limited access to data on firms in the service sector (if any). In the sample of Harhoff et al., for instance, only 30% of the firms belong to the service sector.

[8]Harhoff et al. (1998, 467) in turn compare their results to the study of Wagner (1994) for young firms and find that "the difference is small enough to be accounted for by differences in industry composition."

[9]In the SBC 95, where sole proprietorships are included, we find this group to have the largest share (62.49 percent), at least in terms of their numbers; however, even there the share of stock corporations still is considerable (30 percent).

Table 1: Descriptive Statistics

Variable	Description	Non-Exporting		Exporting	
	Survival				
Duration	Lifetime of the Firm	censored/truncated			
	Size & Age	**Mean**	**Std.D.**	**Mean**	**Std.D.**
Emp	Number of Employees	10.22	48.56	14.26	64.48
Age 95	Firm Age in September 1995	34.42	28.44	33.43	28.19
	Legal Form	**Value**	**Fract.**	**Value**	**Fract.**
Partner	Partnership	0/1	15.50	0/1	8.67
Stock Corp	Stock Corporation	0/1	76.99	0/1	84.88
Lim Liab	Limited Liability Firm	0/1	7.51	0/1	6.45
	Industries				
Food	Food & Textiles	0/1	0.97	0/1	1.51
Leather	Leather & Paper	0/1	4.61	0/1	3.44
Chemicals	Chemicals & Glass	0/1	1.02	0/1	2.78
Metals	Metals etc.	0/1	2.91	0/1	4.05
Machines	Machines & Equipment	0/1	2.90	0/1	10.10
Vehicles	Vehicles.	0/1	0.20	0/1	0.42
Furniture	Furniture, etc	0/1	0.93	0/1	1.30
Utilities	Utilities (Energy & Water)	0/1	0.17	0/1	0.32
Construct	Interior & Exterior Construction	0/1	15.29	0/1	4.75
Veh Trade	Vehicles & Gas Trade	0/1	5.82	0/1	2.45
Wholesale	Wholesale Trade	0/1	10.23	0/1	22.37
Retail	Retail Trade	0/1	12.93	0/1	7.53
Restaurant	Restaurants & Hotels.	0/1	4.81	0/1	1.59
Traffic	Traffic & Communications	0/1	3.01	0/1	4.32
Banks	Banks & Insurances	0/1	1.41	0/1	2.18
Real Estate	Real Estate & Leasing	0/1	2.97	0/1	1.54
Data	Data Processing & Data Bases	0/1	3.62	0/1	4.20
R&D	Research & Development	0/1	0.11	0/1	0.37
Consulting	Consulting	0/1	20.25	0/1	21.42
Education	Education	0/1	0.80	0/1	0.52
Health	Health Services	0/1	1.14	0/1	0.56
Waste	Waste Treatment	0/1	0.26	0/1	0.10
Other	Other Industries	0/1	3.63	0/1	2.20
	Regions				
Eastern CH	Eastern CH	0/1	32.50	0/1	37.51
NW CH	Northwestern CH	0/1	24.92	0/1	24.80
Central CH	Central CH	0/1	9.89	0/1	11.74
French CH	French CH	0/1	26.07	0/1	20.75
Italian CH	Ticino	0/1	6.62	0/1	5.20
	Macroeconomic Conditions	**Mean**	**Std.D.**	**Mean**	**Std.D.**
Ext Value	External Currency Value	102.45	4.82	102.45	4.82
Bankrupt	Number of Bankruptcies	45.70	4.78	45.70	4.78

Source: SCB95, DBED, SNB (2003), own calculations.

3.2 Variables and Descriptive Statistics

We first explain the construction of our dependent variable and then discuss the explanatory variables.

3.2.1 Dependent Variable

Our dependent variable is the firm's lifetime, measured by how many quarters a firm stayed in business (*Duration*). As noted above, the DBED contains three different types of exit: (i) bankruptcies, (ii) voluntary liquidations, and (iii) mergers. In some studies, all three types of exit are pooled (e.g., Dunne and Hughes 1994). Other studies use a more narrow definition of exits—closely related to the concept of "failures"—excluding mergers. In the following, we shall use a broad definition of exits and pool all three types of exit.

In our sample, exits were recorded as bankruptcies if the firms filed for bankruptcy between October 2, 1995, and December 31, 2000. For the exact date of exit, we used the first available date which, in the bulk of bankruptcy cases, is when the court instituted bankruptcy proceedings (as opposed to the date when the firm finally ceased operations). This is due to the fact that the spread between the opening of bankruptcy proceedings and the actual closure varies considerably, depending, for instance, on the size and the legal form of the firm. The other types of exit, voluntary liquidations and mergers, were recorded when the respective firms were deleted from the commercial register. The date when they actually ceased operations would have been preferable, but was not available.

Using the founding and exit times, it is straightforward to calculate the duration of a firm's presence in the market. Note that the resulting duration data is *right censored*; that is, there are (many) firms that have not left the pool during the survey period. For these firms, we know that true duration is at least as large as observed duration. Furthermore, the data is *left truncated*, as all the firms covered by the SBC 95 must have been founded prior to October 1995 and thus have been at risk before coming under observation (delayed entry). Both right censoring and left truncation will have to be taken into account when modelling the probability of exit.

3.2.2 Explanatory Variables

In our sample, all values of firm attributes—including export shares—refer to the date when the firm filed the relevant information for the business

census (i.e., September 1995), similar to Harhoff et al. (1998) and Konings and Xavier (2003). In most other studies, firm attributes refer to the date of the firm's founding. We are aware that some of these attributes—such as the firm's size—may change over the lifetime of the firm. Yet, as in virtually all other studies on business failures, time-varying firm attributes are not available. To deal with this problem, we control for the firm's age at the time of entering the sample (*Age 95*).

In virtually all previous studies, the size of a firm is operationalized by its assets (Dunne and Hughes 1994, Ranger-Moore 1997) or by the number of employees (Brüderl et al. 1992, Audretsch 1995, Harhoff et al. 1998). It is common to log transform the size variable as it is natural to assume that the marginal effects of size on exit probabilities decrease. In the present study, we measure size by the natural log of the number of employees (*LnEmp*); additionally, we include the square of this variable to test for non-monotonicity ($(LnEmp)^2$).[10]

We classify the legal form of firms into four groups, which differ with respect to the initial capital requirements (Brüderl and Schüssler 1990), ease of ownership transfer and liability rules (Harhoff et al. 1998) as well as tax treatment: (i) Partnerships (*Partner*), (ii) limited liability companies (*Lim Liab*), and (iii) stock corporations (*Stock Corp*). As noted above, the fourth legal form, sole proprietorships, had to be dropped because the DBED does not fully cover the failures of these firms.

The SBC 95 further contains information on the nature of the firms' businesses. In our sample, we use 23 dummy variables to control for industry-specific effects. This industry categorization represents the equivalent of the two-digit standard industrial classification (SIC) code for Switzerland. In a simpler specification, we also use the following aggregated industry sectors: Manufacturing (*Manufact*), construction (*Construct*), trade (*Trade*), and services (*Service*).

Furthermore, we use a classification issued by BFS (1997) to control for geographical idiosyncrasies. That is, we use the following five dummy variables to indicate the location of a firm: Eastern Switzerland, including the greater Zurich area and Graubünden (*Eastern CH*), Northwestern Switzerland (*NW CH*), Central Switzerland (*Central CH*), the French-speaking area (*French CH*), and the Italian-speaking area (*Italian CH*). *Eastern CH* will serve as the reference variable.

Since a crucial aspect of our study will be to compare the impact of the

[10] Alternative specifications of firm size (e.g., the number of apprentices or the sales area) can be found in Kaiser (2004).

change in antitrust law on non-exporting and exporting firms, we control for the export share of a firm, calculated as the exports/turnover ratio in September 1995. The database distinguishes the following firm types with respect to export activity: (i) Non-exporting firms, (ii) exporting firms with export shares below one-third, (iii) exporting firms with export shares between one-third and two-thirds, and (iv) exporting firms with export shares above two-thirds. We use the non-exporting firms (*Non-Exporting*) as the reference group and pool all other firms in the group of exporting firms (*Exporting*).

In addition, we use a number of time-varying explanatory variables. The most important ones are dummy variables representing the change in antitrust law in July 1996. In a basic specification, we use the single dummy variable AL, which is set to zero until the second quarter of 1996 and set to one after that. In a refined specification, we use a series of time dummies to assess how the change in antitrust law affected exit rates over time. Another time-varying variable controls for the external value of the Swiss currency (the Swiss Franc), using an index based on the real exchange rates with the 24 most important trade partners published by the Swiss National Bank (SNB) (2003) (*Ext Val*).[11]

Finally, we use a variable controlling for the aggregate movement of the economy in previous years, as in other studies with time-varying covariates. For instance, Van Kranenburg et al. (2002) use the lagged total number of firms while Ranger-Moore (1997) and Roberts and Thompson (2003) use the lagged aggregate number of failures or exits, respectively. We include the lagged number of bankruptcies (*Bankrupt*), generated by aggregating the yearly bankruptcies listed in the DBED.[12] We would expect that a higher number of bankruptcies in the previous year increases hazard rates because of 'chain effects' (at work both within and across industries) that trigger further exits.[13]

[11]We employ a one-year lag specification, so that values between 1994 and 1999 are used for the estimation.

[12]This number is based on all firms, including those not meeting the requirements of the SBC 95.

[13]We use bankruptcies instead of failures (including voluntary liquidations) because we believe that detrimental chain effects are more strongly exerted by bankruptcies than by voluntary liquidations.

Table 2: Exit Rates by Age and Size

Exit Rates* (Failure Rates %, Merger Rates %) Number of Observations					
Firm Age in	**Firm Size in Sept. 1995**				
Sept. 1995	*1-19*	*20-49*	*50-99*	*100*	*Total*
<2	21.5	15.0	11.3	10.3	21.1
	(20.9,0.6)	(13.1,2.0)	(7.8,3.5)	(6.9,3.4)	(20.4,0.7)
	13,365	512	141	87	14,105
2	17.6	17.4	8.9	14.0	17.4
	(16.9,0.7)	(13.8,3.6)	(6.3,2.5)	(9.3,4.7)	(16.5,0.9)
	5,121	224	79	43	5,467
3	18.2	10.6	7.7	20.8	17.6
	(17.4,0.8)	(8.6,2.0)	(7.7,0.0)	(14.6,6.3)	(16.8,0.9)
	4,379	245	78	48	4,750
4	15.7	14.4	9.5	9.3	15.5
	(14.9,0.8)	(11.9,2.5)	(5.4,4.1)	(7.0,2.3)	(14.5,1.0)
	4,658	277	74	43	5,052
5-9	14.8	9.8	10.0	7.4	14.3
	(14.1,0.7)	(8.6,1.1)	(7.9,2.1)	(5.0,2.5)	(13.6,0.8)
	16,858	1,261	331	202	18,652
10-14	12.8	10.0	12.1	8.3	12.5
	(12.1,0.6)	(9.3,0.7)	(10.2,1.9)	(6.9,1.4)	(11.8,0.7)
	10,277	1,012	264	144	11,697
15-25	10.9	8.3	10.4	6.6	10.4
	(10.1,0.7)	(7.1,1.2)	(8.4,2.0)	(4.8,1.9)	(9.6,0.8)
	12,297	1,683	537	377	14,894
Total	15.6	10.5	10.4	8.6	15.1
	(14.9,0.7)	(9.1,1.4)	(8.2,2.2)	(6.0,2.4)	(14.3,0.8)
	66,955	5,214	1,504	944	74,617

*The respective rates indicate the fraction of firms in the cell that exited during the sample period (1999IV-2000IV).

3.3 Preliminaries on the Impact of Size and Age

Table 2 provides the sample frequencies of exits (in percentages)—broken down into failures and mergers—by firm size and firm age. It largely supports the finding of the previous literature that exit rates tend to decrease with *age* (Stinchcombe 1965, Caroll 1983, Amburgey et al. 1993, Olzak and West 1991, Mata and Portugal 1994, Audretsch et al. 2000) and *size* (Brüderl et al. 1992, Barron 1999, Audretsch et al. 2000, Agarwal and Audretsch 2001, Segarra and Callejón 2002).

More specifically, looking at exits by age (rightmost column), we find

that exit rates decrease monotonically, with the exception of a negligible rebound for three-year-old firms. The overall decrease is more than 50 percent, from 21.1 percent for firms younger than two years to 10.4 percent for firms up to 25 years old. For size (bottom row) the decrease is strictly monotonic and amounts to about 45 percent from the smallest to the largest size class. Since the vast majority of exits are failures rather than mergers, these findings similarly apply to failures.

Our figures for age dependence resemble those of Harhoff et al. (1998). Our total average failure rate is 14.3 percent compared with theirs of 10.1 percent. The difference can be explained by our slightly longer observation period and the fact that we excluded the oldest firms (which should be expected to experience below-average failure rates). Moreover, our pattern of failure rates by size resembles theirs in the sense that an age-dependent decline can be observed for the smallest firms, whereas for larger firms, failure rates vary non-monotonically with age and do not show a clear pattern. Hence, for small firms, getting older clearly lowers exit rates; for large firms, the advantages of age are less obvious. However, the bulk of firms in our sample are small, so that their negative duration dependence dominates our findings for the full sample.

As noted above, in addition to failures, exits as defined in the present study include mergers. Our figures show that the propensity to merge rises with the size of the firm, whereas the firm's age does not appear to make a substantial difference. If we look at particular entries in Table 2, we find that firms that are both large and rather young are likely to merge.[14]

4 Empirical Model and Results

Duration models provide a suitable framework for characterizing the probability of exit. Let $T_i, i = 1, ..., n$, denote the continuous duration of firm i's survival in the market. The probability distribution of firm i's duration is characterized by $F_i(t) = \Pr(T_i < t)$, which determines the probability that firm i exits before some t. The corresponding density function is $f_i(t)$. Let $S_i(t) = \Pr(T_i \geq t) = 1 - F_i(t)$ denote the survivor function, which determines the probability that T_i is equal or larger than t. In the following we shall often refer to the *hazard function*

$$h_i(t) = \lim_{dt \to 0} \frac{\Pr\left(T_i \in [t, t+dt] | \, T_i \geq t\right)}{dt} = \frac{f_i(t)}{S_i(t)},$$

[14] Buehler et al. (2005) provide a more detailed analysis of mergers vs. failures.

which, somewhat loosely, is the rate at which firm i exits at time t, given that it has not exited before, as a function of t. The value of this function is called the "hazard rate" or simply the "hazard" (Kiefer 1988; Van den Berg 2001).

4.1 The Cox Model

The Cox proportional hazards model (Cox 1972, 1975) is the most popular approach towards characterizing the hazard function $h_i(t)$ by a vector of observed explanatory variables or covariates. Following Therneau and Grambsch (2000, 39), we use $x_{ij}, j = 1, ..., p$, to denote the jth covariate of firm i, denote the set of covariates by the $n \times p$ matrix $\mathbf{x}$, and let $\mathbf{x}_i$ denote the row vector of firm i's covariates. The Cox model then specifies the hazard function for firm i as

$$h_i(t|\,\mathbf{x}_i) = h_0(t)\exp(\mathbf{x}_i\boldsymbol{\beta}),$$

where $h_0(t)$ is an unspecified non-negative "baseline hazard" which gives the shape of firm i's hazard function, $\exp(\mathbf{x}_i\boldsymbol{\beta})$ is the systematic part of the hazard, and $\boldsymbol{\beta}$ is the coefficient vector. This model is known as the "proportional hazards" model since, for any two firms i and $k, k \neq i$, and *fixed* covariates $\mathbf{x}_i$ and $\mathbf{x}_k$, we immediately have that

$$\frac{h_i(t|\,\mathbf{x}_i)}{h_k(t|\,\mathbf{x}_k)} = \frac{\exp(\mathbf{x}_i\boldsymbol{\beta})}{\exp(\mathbf{x}_k\boldsymbol{\beta})}$$

is constant over time. The parameters $\boldsymbol{\beta}$ may be estimated consistently by maximizing a partial likelihood function that does not depend on the baseline hazard (Kalbfleisch and Prentice 1980).

Clearly, the proportional hazards property no longer holds when (some of) the covariates *vary over time*, as in our case. Nevertheless, we can derive valid econometric inference using the standard Cox model provided that the following conditions are satisfied (Van den Berg 2001, 3398):

(i) $\mathbf{x}(t)$ is a *predictable* stochastic process. The concept of predictability stems from the counting process literature and essentially requires that the explaining variables are weakly exogenous (Ridder and Tunalı 1999, 196). More specifically, predictability implies that the value of $\mathbf{x}_i(t)$ is known infinitesimally before t, at time t^- or even earlier. Put differently, information on the value of $\mathbf{x}_i$ at time t does not help to predict a transition at t.

(ii) The realizations of $\mathbf{x}(t)$ and $\exp(\mathbf{x}_i(t)\boldsymbol{\beta}), i = 1, ..., n$, are *bounded*.

In the present context, it is natural to assume that conditions (i) and (ii) are satisfied. First, consider condition (i). Predictability is satisfied, since our event time scale is discrete and we generally use lagged time-varying covariates (time-invariant covariates are trivially predictable). Next, consider condition (ii). Our time-varying covariates are the time dummies representing the change in antitrust law, the number of bankruptcies (*Bankrupt*), and the external value of the Swiss Franc (*Ext Val*). Clearly, both the time dummies and *Bankrupt* are bounded below and above by definition.[15] Finally, basic economic intuition suggests that *Ext Val* is bounded below and above too.[16]

We shall therefore apply the standard Cox model below to estimate the impact of the change in antitrust law. With time-varying covariates, the Cox model is given by

$$h_i(t|\,\mathbf{x}_i(t)) = \lim_{dt\to 0} \frac{\Pr\left(T_i \in [t, t+dt] |\, T_i \geq t, \{\mathbf{x}_i(u)\}_{u=0}^{t}\right)}{dt} = h_0(t)\exp(\mathbf{x}_i(t)\boldsymbol{\beta}),$$

where $\{\mathbf{x}_i(u)\}_{u=0}^{t}$ denotes the time path of $\mathbf{x}_i$ up to t, that is, $\mathbf{x}_i$ is replaced by $\mathbf{x}_i(t)$ (see Van den Berg 2001, 3397).

4.2 Results

In this section, we present our estimation results.[17] To interpret these results, observe that we do not report the estimated coefficients $\widehat{\beta}_j, j = 1, ..., p$, but the estimated hazard ratios

$$\widehat{H}_j = \frac{\widehat{h}(t|\, x_j = x_j^0(t) + 1, \mathbf{x}_{-j}(t))}{\widehat{h}(t|\, x_j = x_j^0(t), \mathbf{x}_{-j}(t))} = \exp(\widehat{\beta}_j), \quad j = 1, ..., p,$$

where $\mathbf{x}_{-j}(t) = (x_1(t), ..., x_{j-1}(t), x_{j+1}(t), ..., x_p(t))$. The hazard ratio is the factor by which the hazard function is multiplied if the covariate x_j increases

[15] The time dummies are either zero or one by definition. The number of bankruptcies (*Bankrupt*), in turn, is zero at the minimum; at the maximum, it equals the number of firms in the market.

[16] The minimum of *Ext Val* is zero by definition. As to the maximum, observe that for *Ext Val* to go to infinity, the currency values of the most important trade partners (measured in Swiss Francs) would have to approach zero.

[17] We employed STATA 8, using the commands `stsplit` and `stcox`.

by one unit. That is, if $\widehat{H}_j = 1$, the hazard rate does not change in response to a change in covariate j, whereas the hazard increases (decreases) if $\widehat{H}_j > 1$ ($\widehat{H}_j < 1$, respectively).

4.2.1 Basic Specification

Table 3 presents the results from estimating three models that differ with respect to sample composition. The left column reports the estimated hazard ratios for the full sample, whereas the middle and right columns report the estimates for the subsamples of non-exporting and exporting firms, respectively. Our main interest lies in examining the impact of the change in antitrust law in July 1996. In this basic specification, we represent the change in antitrust law by a single dummy variable AL, which is zero before and one after the change.[18]

The pooled regression suggests that the change in antitrust law produced a significant overall increase in hazard rates of roughly 30 percent. This increase in hazard rates is consistent with the idea that the tightening of antitrust law lowered the degree of collusion in domestic markets. However, to substantiate the claim that the increase in hazard rates was generated by more intense competition—rather than some other exogenous "shock" occurring at the same time—it is necessary to compare the effects of the change in antitrust law on firms that are likely to be affected and firms that are not. As pointed out above, this is done by comparing the impact on *non-exporting* firms with the impact on *exporting* firms already facing competition in international markets. The estimated hazard ratios for these models show that the non-exporting firms were the only ones significantly affected by the change in antitrust law. They suffered a significant increase of hazard rates of more than 30 percent. Exporting firms, in contrast, were not significantly affected by the change in antitrust law. Together, these findings suggest that the change in antitrust law indeed raised the intensity of competition in domestic markets, whereas competition in international markets remained largely unaffected.[19] The pooled regression further indicates that the firm's *export activity* is an important determinant of the hazard rate in its own right: Exporting firms are found to have a significantly lower hazard ratio than non-exporting firms.

Concerning *size*, the pooled regression shows that both the natural log

[18]We consider a less restrictive representation of the change in antitrust law below.

[19]Since the vast majority of firms in our sample are non-exporting, the overall impact estimated by the pooled regression is nevertheless large and significant.

Table 3: Estimated Hazard Ratios – Basic Specification

Variable	**All**		**Non-Exporting**		**Exporting**	
	Coeff.	St.E	Coeff.	St.E.	Coeff.	Std.E.
Antitrust						
AL	1.312***	0.075	1.369***	0.087	1.070	0.140
Export Orientation						
Export	0.954*	0.024				
Size & Age						
LnEmp	0.737***	0.016	0.730***	0.018	0.739***	0.034
$(LnEmp)^2$	1.036***	0.005	1.043***	0.006	1.024**	0.011
Age 95	0.951***	0.004	0.956***	0.004	0.929***	0.008
Legal Form						
Stock Corp	0.689***	0.018	0.686***	0.020	0.698***	0.054
Lim Liab	0.735***	0.030	0.735***	0.033	0.727***	0.076
Industry						
Construction	1.240***	0.048	1.173***	0.049	1.899***	0.242
Trade	1.097***	0.034	1.073*	0.039	1.097	0.066
Services	0.959	0.029	0.919**	0.033	1.038	0.062
Region						
NW CH	1.068**	0.029	1.069**	0.032	1.077	0.061
Central CH	1.025	0.037	1.051	0.044	0.946	0.070
French CH	1.204***	0.031	1.236***	0.036	1.083	0.061
Italian CH	1.231***	0.049	1.212	0.055	1.303***	0.107
Macroeconomic Conditions						
Ext Value	1.061***	0.007	1.059***	0.008	1.074***	0.016
Bankrupt	1.065***	0.006	1.064***	0.006	1.072***	0.013
Statistics						
$\mathcal{X}^2$ (all variables)	1961.73***		1447.06***		519.54***	
Log Likelihood	−97328.0		−74157.3		−17805.2	
No. of Obs.	68,681		52,463		16,219	

*,** ,*** Coefficients are significant at the 10%, 5%, 1% level, respectively.

Dummy Coding

AL: before revision (0), after revision (1);
Export: Non-Exporting (0), Exporting (1);
Legal Form: *Partnership* (ref. var.), *Stock Corp*, *Lim Liab;*
Industry: *Manufacturing* (ref. var.), *Construct*, *Trade*, *Services*;
Region: *Eastern CH* (ref. var.), *NW CH*, *Central CH*, *French CH*, *Italian CH.*

of the number of employees ($LnEmp$) and its square (($LnEmp)^2$) are significant. The hazard-reducing effect of $LnEmp$ is countered by a hazard-increasing effect of $(LnEmp)^2$. This indicates that size advantages decrease up to an "optimal size". Further increases of size lead to an increase in hazard rates, giving rise to a $\cup$-shaped relationship between the number of employees and hazard rates. This result, which is supported by the estimation results for the other models, is remarkable as it is commonly accepted that size is positively related to the likelihood of survival.[20] However, many earlier studies have not really addressed the question whether there is a monotone relationship between size and survival, using only one size term. Our results add to studies by Wholey et al. (1992), Dunne and Hughes (1994), Ranger-Moore (1997), Harhoff et al. (1998) and Chen (2002), which suggest that the relation between size and survival may be nonmonotone at least for some industries. In line with the bulk of the literature, we also find that hazard rates decrease with age (*Age 95*) (see Carroll 1983, Olzak and West 1991, Amburgey et al. 1993, Mata and Portugal 1994, and Audretsch et al. 2000).

Table 3 further indicates that *legal form* is an important determinant of firm survival. Stock corporations have lower hazard rates than non-corporate firms. Partnerships (reference variable) are generally most likely to fail, followed by limited liability companies (with a hazard ratio of 0.735) and stock corporations (with a hazard ratio of 0.689). This suggests that the advantages of stock corporations, such as higher initial capital requirements, better access to financial capital, and easier transfer of ownership, apparently dominate their disadvantages due to less risk-averse behavior resulting from limited liability. Our results generally support the rankings of previous studies, such as King and Wicker (1988) and Harhoff et al. (1998).

In this basic specification, we distinguish only the following main *industry sectors*: Manufacturing (reference variable), construction, trade, and services. It stands out that hazard rates for construction are much higher than those for other industries. Harhoff et al. (1998), in contrast, obtained the lowest hazard rates for construction.[21] Potential explanations for the high hazard rates in our case include falling real estate prices and falling

[20] Agarwal and Audretsch (2001, 22) note that "virtually every study undertaken has found that size is positively related to the likelihood of survival."

[21] However, for bankruptcies they also obtained the highest hazard rates for construction, in line with results of Kaiser (2004), who uses the database employed in the present paper.

construction expenses during the survey period.[22]

Regarding the *regions* where firms are located, it is noteworthy that hazard rates in the non-German speaking regions are generally significantly higher than in the German speaking regions. More specifically, relative to the German speaking reference region *Eastern CH*, which includes the greater Zurich area, all regions (except German speaking *Central CH*) suffer from significantly higher hazard rates.

Finally, we consider the impact of macroeconomic conditions on hazard rates. Here, we controlled for the external value of the Swiss currency (*Ext Val*), as its fluctuation influences the exits of firms disparately, subject to their export activity, and its omission could seriously distort findings on the change of antitrust law. We find the external value to be significant in all models. As expected, an increase in the external value of the Swiss currency raises hazard rates, as it deteriorates the competitiveness of Swiss firms in foreign markets and increases the competitiveness of foreign firms in Swiss markets. Furthermore, we included the number of bankruptcies in the previous year (*Bankrupt*) to control for "chain effects" associated with the general business climate.[23] For all models, we find the expected result that the number of lagged bankruptcies raises the propensity to exit.

4.2.2 Refined Specification

Next, we present the results from a refined specification that differs from the simple specification in Table 3 in two ways:

(i) Rather than representing the change in antitrust policy by a single dummy variable, we use a *series of time dummies*. This allows us to assess how the change in antitrust legislation affected exit rates over time. In particular, we examine whether the regime change coincided with the increase in exit rates, and whether the increase in exit rates (if any) was temporary in nature.[24]

[22] According to figures published by SNB (2003), the price index for apartments fell by 23.31 percent from 1994 to 1999; other real estate prices also showed significant decreases. For instance, for one-family houses prices dropped by 13.54 percent and for sales areas by 16.64 percent.

[23] An additional business cycle indicator released by the Swiss Institute for Business Cycle Research (KOF-ETH) turned out to be insignificant and was excluded.

[24] To avoid collinearity problems, we constructed a dummy variable for the time before the regime change in July 1996 and combined the years 1999 and 2000 (using a higher number of time dummies proved to be non-feasible).

(ii) We replace the control variables for the broad industry sectors (manufacturing, construction, trade, and services) by a larger set of dummies (23 variables) allowing for a finer control of industry-specific effects. The refined industry categorization essentially represents the equivalent of the two-digit SIC code for Switzerland.[25]

Table 4 presents the results from estimating the refined specification of the model. First, we focus on the question of how the change in antitrust legislation affected exit rates over time. As for the simple specification, the estimates indicate that the regime change lead to a significant increase in hazard rates of about 30 percent, both for the full sample and the subsample of non-exporting firms.

However, as Figure 1 illustrates, the effect of the regime change on exit rates was probably less persistent than the simple specification in Table 3 suggests: Exit rates increased significantly with the enacting of the revised antitrust law in the second half of 1996 (indicated by the dummy variable *96b*) and then tended to fall again. That is, the effect on exit rates *coincided with the regime change* and was largely *temporary* in nature. We think that the coincidence of the regime change and the increase in hazard rates is particularly noteworthy, as the regime change was made public and thus anticipated by firms.

Second, we consider the more detailed industry categorization in the refined specification. Here, it stands out that exit rates are highest in the food & textiles industry (*Food*, reference variable) and the construction industry (*Construct*). Table 4 further shows that exit rates are particularly low in industries where public adminstration or regulation plays an important role, such as waste treatment (*Waste*), energy & water utilities (*Utilities*), *R&D*, and *Eduction*. The hazard ratios for these variables are all significant (at least for the full sample), whereas those of many other industries are not significant.[26]

[25] We had to aggregate some of these industries, though, to have a sufficient number of observations in each industry.

[26] In part, this may be due to the relatively small number of firms in some industries.

Table 4: Estimated Hazard Ratios – Refined Specification

Variable	**All**		**Non-Exporting**		**Exporting**	
	Coeff.	St.E	Coeff.	St.E.	Coeff.	Std.E.
Antitrust						
96b	1.299***	0.077	1.341***	0.089	1.078	0.141
97	1.268	0.295	1.349	0.337	0.462	0.275
98	1.232	0.619	1.262	0.685	0.237	0.300
99/00	1.162	0.552	1.181	0.601	0.222	0.271
Export Orientation						
Export	0.975	0.025				
Size & Age						
LnEmp	0.728***	0.016	0.718***	0.018	0.734***	0.034
$(LnEmp)^2$	1.037***	0.005	1.045***	0.006	1.024**	0.010
Age 95	0.946***	0.006	0.950***	0.007	0.899***	0.018
Legal Form						
Stock Corp	0.713***	0.019	0.712***	0.021	0.698***	0.054
Lim Liab	0.751***	0.031	0.751***	0.034	0.719***	0.076
Industry						
Leather	0.853	0.087	0.806*	0.095	0.982	0.202
Chemicals	0.770**	0.097	0.897	0.139	0.671*	0.148
Metals	0.737***	0.080	0.718***	0.092	0.783	0.161
Machines	0.738***	0.075	0.718***	0.091	0.818	0.148
Vehicles	0.642*	0.151	0.612	0.183	0.706	0.270
Furniture	0.982	0.124	0.983	0.146	0.966	0.238
Utilities	0.608*	0.165	0.303***	0.136	1.220	0.446
Construct	1.000***	0.094	0.930	0.102	1.583**	0.326
Veh Trade	0.784**	0.796	0.731***	0.085	1.078	0.247
Wholesale	0.845*	0.079	0.846	0.094	0.856	0.150
Retail	0.948	0.890	0.895	0.098	1.105	0.206
Restaurant	0.944	0.097	0.894	0.104	1.091	0.406
Traffic	0.909	0.094	0.843	0.104	1.045	0.202
Banks	0.971	0.111	0.831	0.114	1.371	0.281
Real Estate	0.696***	0.078	0.644***	0.082	1.104	0.309
Data	0.710***	0.074	0.654***	0.080	0.858	0.167
R&D	0.631*	0.167	0.542	0.210	0.764	0.829
Consulting	0.670***	0.650	0659***	0.072	0.791	0.139
Education	0.635***	0.100	0.621***	0.107	0.574	0.237
Health	0.664***	0.095	0.619***	0.097	0.809	0.358
Waste	0.413***	0.130	0.390***	0.130	0.498	0.475
Other	0.975	0.100	0.968	0.114	0.744	0.175

Table continued on next page

Table 4: Estimated Hazard Ratios – Refined Specification (continued)

Variable	**All**		**Non-Exporting**		**Exporting**	
	Coeff.	St.E	Coeff.	St.E.	Coeff.	Std.E.
Region						
NW CH	1.068**	0.029	1.068**	0.032	1.080	0.062
Central CH	1.024	0.037	1.047	0.043	0.955	0.071
French CH	1.189***	0.031	1.220***	0.036	1.060	0.061
Italian CH	1.198***	0.048	1.170	0.054	1.300***	0.107
Macroeconomic Conditions						
Ext Value	1.058***	0.018	1.052***	0.019	1.050	0.042
Bankrupt	1.065***	0.025	1.062**	0.027	1.152**	0.066
Statistics						
$\mathcal{X}^2$ (all variables)	2095.26***		1588.71***		579.45***	
Log Likelihood	−97265.64		−74099.26		−17781.34	
No. of Obs.	68,681		52,463		16,219	

*,**,*** Coefficients are significant at the 10%, 5%, 1% level, respectively.

Dummy Coding

95/96a (ref. var.), *96b*, *97*, *98*, *99/00*: Time Dummies (0/1);
Export: Non-Exporting (0), Exporting (1);
Legal Form: *Partnership* (ref. var.), *Stock Corp*, *Lim Liab;*
Industry: *Food* (ref. var.);
Region: *Eastern CH* (ref. var.), *NW CH*, *Central CH*, *French CH*, *Italian CH.*

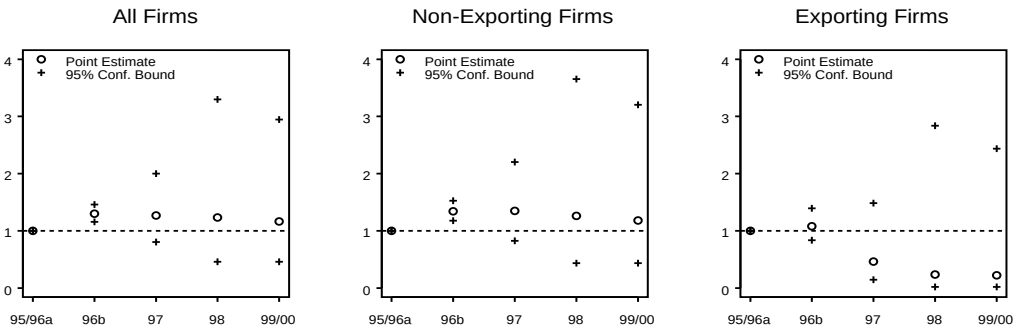

Figure 1: Hazard Ratios for Time Dummies (Refined Specification)

Another important difference between the basic and the refined specification concerns the role of a firm's export activity. With the basic specification, the export activity is estimated to be a significant determinant of

the hazard rate, whereas it is not significant with the refined specification (even though the numerical estimates are fairly similar).

Finally, we note that the basic and the refined specification yield similar estimates for the other variables controlling for size, age, legal form, and so on.

5 Conclusion

We have focused on the question of how an increase in the intensity of product-market competition affects the probability of exit, where the latter may come about by bankruptcy, merger, or voluntary liquidation.

Viewing a rather drastic change in Swiss antitrust legislation in 1996 as an event that generated plausibly exogenous variation in the intensity of competition, we adopted a natural experiment approach to study the relationship between the intensity of competition and the probability of exit.

We established the following main results. First, the change in Swiss antitrust legislation in 1996 led to a significant temporary increase of hazard rates for Swiss firms. Second, whereas non-exporting firms suffered from a significant increase in hazard rates, exporting firms were not significantly affected. Third, our estimates for the other standard determinants of hazard rates are in line with previous literature.

In sum, our results support the notion that there is a positive relationship between the intensity of competition and the probability of exit.

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