Essays in Empirical International Trade and Industrial Organization

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January, 2013 Marco Helm

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Summary

My dissertation is a collection of three essays in the related fields of International Economics and Industrial Organization.

Chapter 1 studies the effect of trade liberalization on growth, using plant-level data from Switzerland. We employ a natural experiment framework to quantify the effect of a bundle of treaties (Bilateral Agreements I) liberalizing trade between Switzerland and the EU enacted in June 2002 on the growth of Swiss plants. Using both a semi-parametric difference-in-differences approach and a matching approach, we find that the liberalization of trade increased the growth of the affected plants by 1%–2% percent during the first six years after liberalization. Our results suggest that trade liberalization has a relevant effect on growth.

Chapter 2 examines the effect of liberalizing trade on exit, using a comprehensive Swiss plant-level data set. The proposed approach is based on a natural experiment which involves a bundle of treaties (Bilateral Agreements I) liberalizing trade between Switzerland and the European Communities. The identification strategy exploits the selective nature of these agreements to estimate the effects using a conditional difference-in-differences approach. The results show a reduction in exit rates of about 1.5 percentage points for the parametric version and 2.3 percentage points for the semi-parametric one. With regard to effect heterogeneity, the small establishments adjust faster than larger ones to the new (lower) level of exit rates. Finally, these findings, which relate liberalized trade and exit rates, add to the existing literature on determinants of firm exits.

Chapter 3 examines the effect of mergers and acquisitions on the growth of employment in newly acquired firm establishments, and is concerned with employees as an important but often neglected stakeholder group. Using a unique census data set on firms in Switzerland, we find that a larger acquirer size has a beneficial effect on employment growth, while a larger size of the newly acquired establishments has an adverse effect. In other words, the size differential between acquirer and target is an

important growth determinant. This distinction is new to the literature. We attribute our finding to the resource constraints of acquiring firms: with high acquisition costs, hiring additional employees is restricted and with lower acquisition costs, hiring additional employees is comparatively unrestricted. In addition, mergers in export oriented industries and between firms in related industries are found to have adverse effects on employment growth. Finally, this paper also contributes to a controversial debate on firm growth in general by rejecting Gibrat's Law of proportionate growth for firm establishments in Switzerland.

Zusammenfassung

Meine Dissertation umfasst drei Kapitel aus den beiden miteinander verbundenen Forschungsfeldern Internationale Wirtschaft (International Economics, JEL-Code: F) und Industrieökonomik (Industrial Organization, JEL-Code: L).

In Kapitel 1 wird untersucht, welchen Einfluss der Abbau von Handelsschranken auf die Entwicklung des Wirtschaftswachstums hat. Die verwendete Strategie nutzt die Implementierung der Bilateralen Verträge I als glaubhaftes natürliches Experiment. Die in diesem Rahmen vereinbarten Abkommen zur Handelserleichterung sind die Basis zum Messen der Effekte auf das Wachstum von Firmen. Als empirische Schätzverfahren werden sowohl das Difference-in-Differences als auch das Matching angewendet. Auf der Grundlage von schweizerischen Mikrodaten (Betriebszählungsstatistik) können wir bei betroffenen Betrieben ein um ein bis zwei Prozent erhöhtes Wachstum innerhalb der ersten sechs Jahre nachweisen. Insgesamt lassen die Ergebnisse die Schlussfolgerung auf einen erheblichen Einfluss der Handelsliberalisierung auf das Wachstum zu.

Kapitel 2 analysiert, anhand von schweizerischen Mikrodaten, die Auswirkung von Handelserleichterungen auf das Austrittsverhalten von Betrieben. Der empirische Ansatz nutzt die bilateralen Verträge als natürliches Experiment. Im Rahmen dieser Abkommen wurde auch eine Liberalisierung des Handels zwischen der Schweiz und den Europäischen Gemeinschaften vereinbart und umgesetzt. Die Identifikationsstrategie nutzt die Tatsache, dass nicht alle Firmen von dieser Vereinbarung betroffen sind, und ermöglicht die Verwendung des Difference-in-Differences Schätzverfahrens. Die Ergebnisse zeigen eine Reduzierung der Austrittsraten um 1.5 Prozentpunkte und 2.4 Prozentpunkte für die parametrische beziehungsweise semi-parametrische Modellvariante. Im Hinblick auf unterschiedliche Effekte auf kleine und grosse Betriebe, zeigen die Ergebnisse ein schnelleres Anpassen der kleineren Betriebe auf Austrittsraten zum neuen (niedrigeren) Niveau. Diese Studie, mit dem empirischen Nachweis eines Zusammenhanges zwischen Handelserleichterungen und Austrittswahrscheinlichkeiten, ergänzt die

bestehende Literatur über Austrittsverhalten von Betrieben um einen weiteren entscheidenden Faktor.

Kapitel 3 untersucht die Auswirkungen auf das Beschäftigungswachstum in Betrieben, welche im Zuge von Fusionen oder Übernahmen neu erworben wurden. Insbesondere wird in dieser Studie auf die wichtige aber sonst eher wenig beachtete Gruppe der Beschäftigten eingegangen. Unter Verwendung von schweizerischen Mikrodaten (Betriebszählungsstatistik) auf Arbeitsstättenebene finden wir, dass je grösser die kaufende Firma, umso höher ist das Beschäftigungswachstum, allerdings wirkt sich die Gesamtgrösse der zu integrierenden Betriebe negativ auf das Wachstum aus. Die Erkenntnis, dass der Grössenunterschied zwischen dem Käufer und den neu zu integrierenden Einheiten ein entscheidender Bestimmungsfaktor für das Wachstum ist, erweitert die bestehende Literatur. Wir führen dieses Ergebnis auf beschränkte Ressourcen des Käufers zurück, d.h. mit relativ hohen Akquisitionskosten sind Betriebsmittel gebunden und nicht für weitere Anstellungen von Mitarbeitern verfügbar und umgekehrt. Bei Übernahmen in Exportindustrien und zwischen Firmen in verbundenen Industrien finden wir negative Effekte auf das Beschäftigungswachstum. Diese Studie leistet auch einen Beitrag zur kontroversen Debatte über Firmenwachstum im Allgemeinen. In diesem Zusammenhang finden wir für schweizerische Betriebe keine Bestätigung für Gibrats Gesetz des proportionalen Firmenwachstums.

Introduction

This dissertation is a collection of three essays in the related fields of International Economics and Industrial Organization. The first two chapters analyze economy-wide structural change through (liberalizing) trade. The third part deals with employment changes at the plant level in the course of mergers and acquisitions.

Chapter 1 examines empirically the question: What is the effect of trade liberalization on economic growth? Much effort has been devoted to answering this question, yet there is arguably little persuasive empirical evidence. The key difficulty in providing persuasive evidence is to identify the direction of causation between trade and growth (Frankel and Romer, 1999; Irwin and Terviö, 2002). Other major difficulties include the measurement of a country's openness to trade, and the plausible isolation of the effects of trade liberalization from other events (Edwards, 1993; Rodríguez and Rodrik, 2000; Yanikkaya, 2003; Wacziarg and Welch, 2008). In view of these difficulties, Winters (2004, F4) finds that the most plausible conclusion from a survey of the literature is that trade liberalization "generally induces a temporary (but possibly long-lived) increase in growth." In another survey, López (2005, 623) offers a gloomier view of the literature, stating that "neither the existing theoretical models nor previous empirical analyses seem to have produced a definitive and positive answer to this area of inquiry."

Together with my co-authors Stefan Bühler and Michael Lechner, I propose a policy evaluation approach towards estimating the effect of trade liberalization on growth.[1] This approach is designed to quantify the causal effect of an exogenous policy change on the relevant outcome variables of a population of subjects in a natural experiment (Meyer, 1995) framework, thereby circumventing the difficulties mentioned above. Specifically, we view the enactment of a bundle of treaties between Switzerland and the European Union in June 2002, i.e., the Bilateral Agreements I (BAI), as a plausibly exogenous instance of trade liberalization and estimate its impact on the growth of

[1] See Angrist and Pischke (2008), Blundell and Costa Dias (2009), and Imbens and Wooldridge (2009) for recent surveys of the policy evaluation literature.

business plants in Switzerland, using micro data on the universe of Swiss plants from 1995 to 2008.

The estimation results obtained by using two causal approaches (matching and difference-in-differences) are quite similar and indicate an increase in growth for the post-liberalization periods, although the matching results are somewhat less precise. In particular, our findings suggest that the liberalization of trade increased the growth of the affected plants by 1%–2% during the first six years after liberalization. The extra growth of the strongly affected plants during the same time is estimated to be higher (up to around 4%–5%). In addition, the estimates indicate that, just prior to their enactment, the BAI transitionally reduced the average growth of the affected plants by up to 2%. The latter result is consistent with the notion that plants improve their productivity in anticipation of a market opening (cf. López (2005)).[2]

Chapter 2 continues to investigate structural change in the course of liberalized trade. Based on predictions of the new-new trade theory, this part of my thesis is concerned with the effects of liberalizing trade on exit. The economic literature has already been interested in explaining the consequences of trade for a long time. The traditional trade theory surveyed by Bhagwati (1964) focuses (for example in Ricardo's model) on comparative advantages to in order to address the issue of gains from specialization across countries. The new trade theory goes beyond this country level analysis, and explains empirical patterns by industry level differences (Krugman, 1981). In addition, the new-new trade theory (Melitz, 2003; Bernard et al., 2003) introduces heterogeneity at the firm level, which predicts essentially two outcomes in response to a more open trade policy: First, there occurs a reallocation of market shares towards the more productive firms. Second, the least productive firms exit the market and, as mentioned above, this is here investigated empirically.

Based on the same unique dataset, which includes plant-level observations covering the whole Swiss economy for the years 1995 to 2008, I analyze the effect of trade liberalization on a change in exit rates according to the predictions of the new-new trade theory. Therefore, in my empirical analysis, I exploit again the substantial reduction of the trade barriers between Switzerland and the European Community which is part of the Bilateral Agreements I (BAI) enacted in 2002. This allows applying a conditional difference-in-differences strategy for the empirical investigation and is a rare case of a plausible exogenous variation with observations before and after a natural experiment.

[2]This result needs to be interpreted carefully, though, since we cannot directly observe plant productivity and must assume that plant output was not reduced.

In this respect, it is more reliable than, for example, Pavcnik (2002) which lacks any data preceding the trade policy reform.

The results indicate a negative effect on the exit rate for all post-liberalization periods. More specifically, after enactment of the BAI (in the year 2002), there is an absolute reduction of the exit rate by roughly 1.3 percentage points for the first three years. This short term change is substantial, considering that the average level of exit rate is about 20% (for a three year period). In the longer term (i.e., five to eight years after the implementation), the exit rate is reduced by 1.5 percentage points, indicating the persistence of the effect. These findings are robust for the parametric and the semi-parametric specifications of the model. Moreover, one year before the enactment, the results show a reduction of exit rates, too. This is called the anticipation effect because it appears immediately after the referendum is agreed. Furthermore, the new-new trade theory suggests heterogeneous effects depending on productivity levels (cf. Melitz (2003)). Admittedly, the necessary direct productivity measures are not available, but in this literature, small firms are small because they have high marginal costs. Hence, I use a plant's size as a proxy for its productivity and split the sample at the median between small and large plants. In the short term, large establishments reduce their average exit rate by almost 1.0 percentage points compared to 1.5 percentage points for the small ones. In the long term, the two subsamples exhibit only marginal differences. Hence, the adjustment time, which is the period until the new level of survival is observed, is shorter for smaller than for larger plants. A potential explanation is that smaller firms are more flexible and benefit more rapidly from the additional demand opportunities.

While focusing on economy-wide effects in the first two parts, Chapter 3 deals with employment changes at the plant level in the process of mergers and acquisitions. Acquiring firms are concerned about the cultural fit between the old and new parts of the workforce, additional employees increase the complexity of management, and new points of personal contact and cooperation need to be established. At the same time, employees of the target firm undergo reorganizations and face a new employer with different standards and expectations. The resulting insecurity is even more intense if foreign investors are involved. In some cases, the situation even turns into a public policy concern through public demonstrations by employees who feel threatened with mass layoffs. Apart from anecdotal evidence, however, fairly little is actually known

about how mergers and acquisitions affect the employment in newly acquired target firms.[3]

In this chapter, my co-author Dirk Burghardt and I use the complete inventory count of firm establishments in Switzerland to study the changes in employment in the course of mergers and acquisitions. Of about 350,000 establishments that constitute the Swiss services and manufacturing sector in the year 2001, we identify 5,389 firm establishments acquired by another firm in the subsequent four years. This number also includes very small plants which are typically overlooked by other studies. Our empirical model relates the growth in employment of each establishment to a number of explanatory variables: at first, the variables that have been identified as general growth determinants by the literature, such as the initial size or the age of an establishment are included. More importantly, however, we investigate how the status of being "recently acquired" influences growth.

Four results stand out. First, we find that the growth of (surviving) firm establishments decreases with their initial size and age. For establishments in Switzerland we can thus reject Gibrat's Law of proportionate growth. This result contributes to the ongoing discussion on the growth of firms and firm establishments in general. Second, turning to the analysis of mergers and acquisitions, we find that the size of the acquiring firm is positively related to the growth of the newly acquired plant, while the (combined) size of the newly acquired establishments is negatively related to its growth. In other words, the size differential between acquirer and target is an important determinant for the internal growth of a newly acquired establishment's workforce. This finding is new to the literature. There are several possible explanations, such as that the acquiring firm has constrained resources, which means that with high acquisition costs, hiring additional employees is financially restricted and with lower acquisition costs, hiring additional employees is comparatively unrestricted. It is also possible that with relatively large acquisitions, firms simultaneously increase their market power to a larger extent. Subsequent production is reduced, requiring less employees. Furthermore, managerial capacities may be exhausted, and thus hiring tasks delayed. Third, mergers and acquisitions in export oriented industries and within related industries are associated with adverse effects on employment growth. These findings may result from a higher competitive pressure in export industries and more possibilities for streamlin-

[3] A vast amount of research does exist, however, on the effects of mergers and acquisitions on shareholder value. Recent studies include Fuller et al. (2002), Graham et al. (2002), and Moeller et al. (2005). See Martynova and Renneboog (2008) for a survey.

ing measures when similar businesses merge. Fourth, we find that foreign-owned plants on average grow more rapidly than other plants which might be related to a technology transfer from their foreign owners.

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Chapter 1

Trade Liberalization and Growth: Plant-Level Evidence from Switzerland

joint with Stefan Bühler and Michael Lechner

1.1 Introduction

What is the effect of trade liberalization on economic growth? Great effort has been devoted to answering this question, yet there is arguably little persuasive empirical evidence. The key difficulty in providing persuasive evidence is to identify the direction of causation between trade and growth (Frankel and Romer, 1999; Irwin and Terviö, 2002). Other major difficulties include the measurement of a country's openness to trade, and the plausible isolation of the effects of trade liberalization from other events (Edwards, 1993; Rodríguez and Rodrik, 2000; Yanikkaya, 2003; Wacziarg and Welch, 2008). In view of these difficulties, Winters (2004, F4) finds that the most plausible conclusion from a survey of the literature is that trade liberalization "generally induces a temporary (but possibly long-lived) increase in growth". In another survey, López (2005, 623) offers a more gloomy view of the literature, stating that "neither the existing theoretical models nor previous empirical analyses seem to have produced a definitive and positive answer to this area of inquiry."

In this paper, we propose a policy evaluation approach towards estimating the effect of trade liberalization on growth.[1] This approach is designed to quantify the causal effect of an exogenous policy change on the relevant outcome variables of a population of subjects in a natural experiment (Meyer, 1995) framework, thereby circumventing the difficulties mentioned above. Specifically, we view the enactment of a bundle of treaties between Switzerland and the European Union in June 2002—the "Bilateral Agreements I"[2]—as a plausibly exogenous instance of trade liberalization and estimate its impact on the growth of business plants in Switzerland, using micro data on the universe of Swiss plants from 1995 to 2008.

To implement this approach, we carefully study the contents of the seven treaties and employ the Swiss equivalent of the Standard Industrial Classification (SIC) code at the two-digit level to assign individual plants to the groups of 'non-affected', 'affected', and 'strongly affected' plants, respectively. Based on this classification, we use a difference-in-differences (DiD) approach[3] to estimate the effect of the Bilateral Agreements I on plant growth in Switzerland. The idea is that, if the non-affected and the affected plants were subject to the same time trends (i.e., similar plant growth) and if trade liberalization had no effect in the pre-liberalization period, we can use the mean change in the size of the non-affected plants and add it to the mean size of the affected plants prior to the liberalization to construct the mean counterfactual size the affected plants would have reached if they had not been subject to trade liberalization. Of course, we control for exogenous variables that would have led to differential time trends in the absence of trade liberalization.[4] To ensure a high robustness of our results against potential misspecification of the relation between outcome and control variables, we do this in a semi-parametric way based on the propensity score.

We also adopt a matching approach (Rubin, 1978) to check the robustness of our result to a slight, but potentially important, variation of the identifying assumptions.[5] The key difference between the matching and the DiD methodology concerns the role of the pre-liberalization outcomes for constructing the non-observable counterfactual outcome. With matching, these outcomes are used together with exogenous variables

[1] See Angrist and Pischke (2008), Blundell and Costa Dias (2009), and Imbens and Wooldridge (2009) for recent surveys of the policy evaluation literature.

[2] The Bilateral Agreements I prescribe a significant reciprocal market opening in seven areas: technical trade barriers, free movement of persons, agricultural products, public procurement, ground transportation, civil aviation, and scientific and technological cooperation. We provide further details on these agreements in Section 1.2 below.

[3] See Lechner (2010) for a recent survey on the estimation of causal effects by DiD methods.

[4] We will detail our econometric approach in Section 1.4.

[5] See Imbens and Wooldridge (2009) for a recent survey on matching methods.

to find plants not subject to trade liberalization which are similar to plants subject to liberalization. They are then used to estimate the counterfactual outcomes. With DiD, in turn, plants are made identical with respect to the exogenous variables only, and the pre-liberalization outcomes are directly subtracted from the post-liberalization outcomes to estimate the missing counterfactual trends.[6]

The estimation results of the DiD approach are similar to those of the matching approach, even though the latter are somewhat less precise. Our results suggest that the liberalization of trade increased the growth of the affected plants by 1-2 percent during the first six years after liberalization. The extra growth of the strongly affected plants during the same time is estimated to be higher (up to around 4-5 percent). In addition, the estimates indicate that, just prior to their enactment, the Bilateral Agreements I transitionally reduced the average growth of the affected plants by up to 2 percent. The latter result is consistent with the notion that plants improve their productivity in anticipation of a market opening (cf. López (2005)).[7]

It is instructive to compare our microeconometric estimates with the macroeconomic evidence recently reported by Wacziarg and Welch (2008). Building on Rodríguez and Rodrik (2000), these authors provide an updated version of the classic cross-country study by Sachs and Warner (1995). Using data from 1950 to 1998, they find that countries which liberalized their trade regimes experienced average annual growth rates that were about 1.5 percentage points higher than before liberalization. In a related cross-country study, Mattoo et al. (2006) find that countries with fully open telecom and financial services sectors grow up to 1.5 percentage points faster than other countries. These results are fairly similar to our findings both in terms of the sign and the size of the estimated effect, even though the authors use very different data and econometric techniques.[8]

This paper contributes to three related strands of the literature. First, by exploiting a plausibly exogenous variation in trade policy and using micro data on the universe of an economy's plants to provide an estimate of the causal effect of trade liberalization on growth at the plant level, we introduce the policy evaluation approach into the literature on the effect of trade liberalization on growth surveyed by Rodríguez and

[6]That is, once pre-liberalization outcomes are used as conditioning variables in DiD, matching and DiD are identical.

[7]The result needs to be interpreted carefully, though, since we cannot directly observe plant productivity and must assume that plant output was not reduced.

[8]López (2005, 628) provides a list of other well-cited cross-country studies which find a positive and statistically significant correlation between some measure of openness to trade and economic (or productivity) growth.

Rodrik (2000), Winters (2004), and López (2005). To the best of our knowledge, this is the first microeconometric study of the effect of trade liberalization on growth. Our approach exploits the heterogeneity available in a large population of business plants and is well-suited to circumvent many of the difficulties plaguing previous empirical contributions to this strand of the literature. In contrast to previous work, which often focused on developing countries, this paper considers a small open economy in the middle of Europe with a well-developed service sector. In doing so, our analysis sheds new light on the subtle relation between trade policy and economic growth.

Second, our analysis provides further evidence on the new trade theory pioneered by Melitz (2003) and Bernard et al. (2003).[9] Assuming that firm productivity is fixed, the new trade theory predicts that trade liberalization leads to the exit of the least productive firms and the reallocation of market shares towards more productive firms. That is, according to the new trade theory, trade liberalization should have a negative (positive) effect on the growth of the least (most) productive firms, whereas the average effect on the affected firms is generally ambiguous. Our finding of a significant and positive growth effect on the affected plants is consistent with the predictions of the new trade theory. Note, however, that we cannot directly test these predictions with our data, since we do not observe productivity.

Third, our analysis adds to related work by Pavcnik (2002), Trefler (2004), Ederington and McCalman (2008), and Bustos (2011). These papers emphasize that trade liberalization not only generates a reallocation of market shares towards more productive firms, but also increases the productivity within firms. In particular, trade liberalization may induce firms to purposefully increase their productivity in anticipation of trade liberalization (López, 2005), or to use the resulting revenue increase for technology upgrading after trade liberalization (Bustos, 2011). Our estimates are consistent with such productivity increases both before and after the opening of the Swiss economy towards the European markets.

We believe that the evaluation of changes in macroeconomic (e.g., trade) policy at the microeconomic (e.g., plant) level offers a promising avenue for future research. In particular, the increasing availability of comprehensive plant-level data sets provides interesting new opportunities for analyzing the impact of major policy changes on relevant outcome variables at the micro level (e.g., plant size, plant productivity, etc.).

[9]More recent work includes Melitz and Ottaviano (2008), Baldwin and Forslid (2010), Redding (2010), Bernard et al. (2010), and Eaton et al. (forthcoming). Panagariya (2000) provides a useful survey of the theory of preferential trade liberalization.

Regarding the impact of trade liberalization on growth, it would be interesting to compare the results of our analysis to similar microeconometric studies of other instances of trade liberalization.[10] A collection of such studies is likely to provide persuasive empirical evidence on the impact of trade liberalization on economic growth.

The remainder of the paper is structured as follows. Section 1.2 provides a survey of Switzerland's trade policy towards the European Union, and discusses the contents of the treaties forming the Bilateral Agreements I. Section 1.3 describes the data base, explains the classification of individual plants into groups of non-affected, affected, and strongly affected plants, and provides a first descriptive analysis. Section 1.4 discusses the empirical research design, the plausibility of the required identifying assumptions, and our estimation approach. Section 1.5 provides the results from estimating the causal effect of trade liberalization on plant growth. Section 1.6 concludes. The Appendix provides detailed information on the construction of our sample, the complete classification of plants, and further supporting material.

1.2 Swiss Trade Policy towards the European Union

Switzerland is a small open economy located in the middle of Europe. The country is a member of the European Free Trade Association (EFTA),[11] but belongs neither to the European Economic Area (EEA) nor to the European Union (EU).[12] Instead, Switzerland's relations to the EU are governed by a set of bilateral agreements surveyed below.

1.2.1 Survey of Bilateral Agreements

Over the last decades, the following agreements between Switzerland and the EU (or the European Community, respectively) were concluded (see Integration Office, 2009):[13]

(1) *Free Trade Agreement of 1972*: This agreement forms the basis of the close economic relations between Switzerland and the EU.[14] It prohibits tariffs and quotas

[10] A related study by Revenga (1997) on the impact of trade liberalization on Mexican manufacturing employs different econometric techniques and does not consider the impact on growth.

[11] At the time of writing, the other EFTA members are Iceland, Liechtenstein, and Norway.

[12] The national currency is the Swiss Franc (CHF).

[13] Updated information is available at: `www.europa.admin.ch/themen/00500/index.html?lang=en`.

[14] The EU is Switzerland's most important trade partner. In 2008, bilateral trade per day passed 1 billion CHF. Roughly every third CHF was earned through trade with the EU, and roughly 80% of Swiss exports went to the EU. Conversely, Switzerland was the third-largest trading partner of the EU behind the U.S. and Russia, but ahead of China (Integration Office, 2009, 4).

on industrial products (e.g. watches and machines) between Switzerland and the EU, but falls short of a customs union.

(2) *Insurance Agreement of 1989*: This agreement guarantees insurance companies the mutual right to establish operations in the territories of the contracting parties.

(3) *Bilateral Agreements I*: This is a bundle of agreements which goes well beyond the Free Trade Agreement of 1972 and prescribes further market opening in seven areas: technical trade barriers, free movement of persons, agricultural products, public procurement, ground transportation, civil aviation, and scientific and technological cooperation.[15] The Bilateral Agreements I were approved by the Swiss electorate in May 2000 (approval rate: 67%) and are effective since June 1, 2002.

(4) *Bilateral Agreements II*: This bundle of agreements concerns further interests. In particular, it extends cooperation to the fields of internal security, asylum, the environment, and culture. These agreements were jointly approved in June 2005 (approval rate: 55%), but the time of enactment varies considerably across the individual agreements.

In our empirical analysis below, we will focus on the Bilateral Agreements I. These agreements are designed to liberalize (and safeguard) free trade between Switzerland and the EU. The Bilateral Agreements II, in turn, extend the mutual cooperation to asylum, security, and environmental policy and have little (if any) relevance for international trade. Our focus on the Bilateral Agreements I is further warranted by the fact that they have a single and well-defined date of enactment (June 1, 2002) which happens to be in the middle of our panel data set on the universe of Swiss plants ranging from 1995 to 2008.[16]

1.2.2 The Bilateral Agreements I

The Bilateral Agreements I implemented a mutual opening of Swiss and EU markets in seven areas. We briefly discuss the respective contractual agreements, based on information provided by the Integration Office (2009).

(A) *Technical trade barriers.* The so-called "Mutual Recognition Agreement" (MRA) stipulates the mutual recognition of conformity tests for most industrial products.

[15] See Section 1.2.2 for further details.

[16] We will provide a more detailed description of our data in Section 1.3.

Conformity tests certify that a product complies with the relevant regulations and may be offered on the market. The agreement covers diverse groups of industrial products, including machines, printers, medical products, motor vehicles, tractors, measuring instruments, telecommunications devices and (since March 2008) building materials (Integration Office, 2009, 14). The mutual recognition of conformity tests simplifies bilateral trade between Switzerland and the EU considerably. It implies, in particular, that any product approved in either Switzerland or the EU can be introduced in both markets, eliminating the need for double conformity testing.

(B) *Free movements of persons.* The agreement ensures equal treatment of Swiss and EU citizens in taking up residence and work. In particular, it improves the gradual mutual opening of labor markets, stipulates the recognition of professional diplomas, and coordinates the different social security systems.

(C) *Agricultural products.* The agreement liberalizes the cheese market (free trade since June 2007) and simplifies trade in other agricultural products by reducing customs duties and eliminating non-tariff barriers to trade.

(D) *Public procurement.* The agreement extends WTO rules and subjects larger tenders by municipalities and licensed firms (e.g., telecommunications and railway operators) to compulsory tendering.

(E) *Ground transportation.* The agreement increases the maximum weight limit for heavy trucks from 28 to 40 tonnes and prescribes the introduction of a Pigouvian tax on heavy vehicles, which provides incentives for moving transalpine freight from road to rail.

(F) *Civil aviation.* The agreement stipulates reciprocal access to aviation markets (including landing rights).

(G) *Scientific and technological cooperation.* The agreement improves the participation of Swiss research institutions and individuals in EU research programs.

1.3 Data

As mentioned in the introduction, the empirical analysis will exploit the cross-sectional variation in the extent to which plants were affected by the liberalization. Our panel

data set allows us to combine this variation with the longitudinal variation from the fact that even the (strongly) affected plants were unaffected by the liberalization years before the market opening. In this section, we begin with describing the data base and classifying the plants into groups of non-affected, affected, and strongly affected plants, respectively. Next, we characterize the sample actually used and provide some descriptive statistics for the various groups of plants.

1.3.1 Data Base

Our analysis is based on five waves (1995, 1998, 2001, 2005 and 2008) of the Swiss Business Census, which is a complete inventory count of all business establishments with more than 20 weekly aggregate working hours (excluding the agricultural sector). The Business Census is compiled by the Federal Statistical Office, and participation is mandatory. The Business Census provides detailed plant-level information on individual firms. In particular, it covers the number of employees (as well as their gender, nationality, etc.), the geographic location, and the industry classification, using the Swiss equivalent to the SIC code. Our database is unique in sample size, coverage of economic sectors and length of the observation period. In particular, it includes the service sector (e.g., wholesale and retail trade, banking, etc.), which is of crucial importance for the Swiss economy.

There are a two drawbacks of our data as well. First, we lack information about the productivity of individual plants or firms. Second, we cannot observe the outputs (or prices) of individual plants and therefore use the level of employment in full-time equivalents (FTEs) as a proxy for plant size. Nevertheless, if we accept the level of employment in FTEs as a reasonable measure of plant size, the database is well-suited to examine the effect of trade liberalization on plant growth.

1.3.2 Classification of Plants

We classify individual plants as non-affected, affected, or strongly affected, respectively, by the Bilateral Agreements I, based on an assessment of the extent to which a plant's (two-digit level) industry was affected by the seven agreements (A)-(G) discussed in Section 1.2.2.[17] Let us illustrate this assessment, using industry 33 ("Medical Apparatus, Precision Instruments") as an example. For each individual agreement, we studied the official documentation and determined whether it affected industry 33. We

[17]We acknowledge that this assessment involves some judgement on our part.

found that this industry was affected by agreements (A), (B) and (D), but not by the other agreements. In light of our finding that industry 33 was affected by three out of seven agreements, we classified it as strongly affected and assigned it to group "2".[18] Industries affected by less than three agreements, in turn, were typically classified as affected (group "1") or "non-affected" (group "0"), respectively. Table 1A.1 in the Appendix provides the complete classification of all industries and further details on our assessment of individual industries.

Table 1.1 summarizes our classification of plants by industry. It shows each industry's classification into one of the three groups as well as the number of plants in that industry. Several comments are in order. First, the group of strongly affected plants is dominated by manufacturing industries 29 ("Machinery, Equipment") and 33 ("Medical Apparatus, Precision Instruments"). They jointly account for roughly 70% of the 8,602 plants. Agreement (A) lists these industries among those which particularly benefit from the elimination of technical trade barriers. Second, in the group of affected firms, the service industries 50 ("Trade Vehicle") and 51 ("Wholesale and Commission Trade") account for almost 65% of the 44,662 plants. These industries are affected, for instance, by the "packing conformity" stipulated by agreement (A). Third, a considerable number of industries, in particular in the service sector (e.g., 52 "Retail Trade", 55 "Lodging and Restaurants", etc.) is not affected by the Bilateral Agreements I. The 187,672 non-affected plants in these industries form the control group.[19]

1.3.3 Sample

Since we are interested in estimating the impact of trade liberalization on the growth of profit-oriented plants, we deleted cooperatives ("Genossenschaften"), associations and clubs ("Vereine"), foundations ("Stiftungen"), as well as churches, embassies and international organizations from our sample. In addition, we dropped industries with a negligible number of plants (e.g., mining) and non-profit oriented industries dominated by public administration (e.g, education, and health care and welfare). Finally, since our identification strategy requires pre-liberalization outcomes and covariates, we restricted the sample to firms which were active both in 1995 and 1998. Table 1A.2 in the Appendix shows how deleting these groups of plants affects the sample size. To avoid any selection bias due to liberalization-induced exit, we kept non-surviving plants after

[18] None of the industries was affected by more than three agreements.

[19] Potentially, all industries might have been affected by agreement (B). However, the inflow of workers from EU countries was, and continues to be, severely limited by quotas (see Section 1.4.2).

Table 1.1: Classification of Plants by Industry

		Group Classification			Percentage within	
	Industry	"0"	"1"	"2"	Group	Total
	Manufacturing					
15	Food and Luxury Food	0	2,678	0	6.00	1.11
16	Tobacco Products	0	19	0	0.04	0.01
17	Textiles	0	802	0	1.80	0.33
18	Apparel	0	851	0	1.91	0.35
19	Leather Products	0	300	0	0.67	0.12
20	Wood, Cork, etc.	0	5,909	0	13.23	2.45
21	Paper	0	240	0	0.54	0.10
22	Publishing, Printing	3,872	0	0	2.06	1.61
23	Koke, Refined Petroleum	21	0	0	0.01	0.01
24	Chemicals	0	764	0	1.71	0.32
25	Syntheticals	0	750	0	1.68	0.31
26	Glass, Ceramic	1,291	0	0	0.69	0.54
27	Production of Metal	299	0	0	0.16	0.12
28	Metal Products	6,550	0	0	3.49	2.72
29	Machinery, Equipment	0	0	3,428	39.85	1.42
30	Business Machines	0	0	133	1.55	0.06
31	Electric Machinery	0	0	1,123	13.06	0.47
32	Radio, TV, Communication	0	0	582	6.77	0.24
33	Med. Appar., Precision Instr.	0	0	2,803	32.59	1.16
34	Automobiles and Parts of Cars	0	0	208	2.42	0.09
35	Other Vehicles	0	0	325	3.78	0.13
36	Furniture, Jewelry, etc.	0	3,476	0	7.78	1.44
37	Recycling	255	0	0	0.14	0.11
	All Manufacturing Industries	12,288	15,789	8,602		15.22
	Services					
40	Energy Supply	336	0	0	0.18	0.14
41	Water Supply	26	0	0	0.01	0.01
45	Construction	28,486	0	0	15.18	11.82
50	Trade Vehicles (also Parts)	0	12,659	0	28.34	5.25
51	Wholesale and Commission Trade	0	16,214	0	36.30	6.73
52	Retail Trade	44,136	0	0	23.52	18.32
55	Lodging and Restaurants	23,317	0	0	12.42	9.68
60	Land Transportation, Pipelines	6,090	0	0	3.25	2.53
61	Water Transportation	108	0	0	0.06	0.04
62	Air Transportation	221	0	0	0.12	0.09
63	Auxiliary Transport Activities	2,971	0	0	1.58	1.23
64	Post and Telecommunications	260	0	0	0.14	0.11
65	Banks, Funds	2,916	0	0	1.55	1.21
66	Insurance Companies	1,618	0	0	0.86	0.67
67	Banking Business Activities	1,490	0	0	0.79	0.62
70	Real Estate and Housing	2,469	0	0	1.32	1.02
71	Renting of Goods and Chattels	665	0	0	0.35	0.28
72	Data Processing and Data Bases	4,232	0	0	2.25	1.76
73	Research and Development	241	0	0	0.13	0.10
74	Other Business Activity	39,288	0	0	20.93	16.31
90	Sewage and Waste Treatment	325	0	0	0.17	0.13
91	Sp. Intr. Groups, Relig. Org.	424	0	0	0.23	0.18
92	Culture and Sports Activities	3865	0	0	2.06	1.60
93	Other Services	11,900	0	0	6.34	4.94
	All Services Industries	175,384	28,873	0		84.78
	All Industries	187,672	44,662	8,602		100.00

Notes: Shown is the number of plants by industry in 1995, classified into non-affected ("0"), affected ("1"), and strongly affected ("2") plants, as well as their shares in the respective group and the full sample. The total number of plants is 240,936 with 36,679 units in the manufacturing and 204,257 units in the service sector.

1998 in the sample, but set their employment levels to zero.[20] Table 1A.3 in the Appendix provides more detailed information on the number of plants and plant exit. It shows, not surprisingly, that the probability of closure is considerably higher for smaller plants than for larger plants. This finding holds for all three groups.

1.3.4 Descriptive Statistics

A relevant question for our analysis is whether the firms in the different groups are similar with respect to their characteristics. Next, we therefore provide descriptive statistics for the pre- and post-liberalization plant characteristics by group and year, respectively.

Inspection of Table 1.2 indicates that, pre-liberalization, the three-year growth rates of plant employment (from 1995 to 1998, and from 1998 to 2001, respectively) were around ten percent for all groups.[21] The average number of employees per plant, in turn, varied considerably across groups. The average size of non-affected plants (around seven FTEs) was slightly smaller than that of affected plants (around ten FTEs), and much smaller than that of strongly affected plants (above 25 FTEs) in all years. The share of manufacturing firms was highest in the group of strongly affected firms (more than 75 percent). This is as expected because the Bilateral Agreements I were meant to facilitate trade in industrial products. Similarly, for 1995, we find that the share of exporting and importing plants was highest in the group of strongly affected firms (around 45 and 52 percent, respectively).[22] The pattern is less clear for the other pre-liberalization plant characteristics.

Table 1.3 shows that, after liberalization, the growth rates were around seven percent from 2001 to 2005, and around eight to eleven percent from 2005 to 2008. That is, except for the group of strongly affected plants, growth rates were consistently lower than in the pre-liberalization period. The average number of employees per plant, in turn, increased slightly. Specifically, the average size of non-affected plants increased from around seven FTEs in the pre-treatment period to around eight (2005) and nine (2008) FTEs in the post-treatment period, whereas the size of affected plants increased from around ten FTEs to around twelve (2005) and thirteen (2008) FTEs.[23] The share of the

[20] This is feasible because the only post-1998 information needed for the estimation is based on employment levels which are well defined even if a plant is closed.

[21] Note that the 1995-1998 comparison covers only firms with positive employment in both years.

[22] This information is available only for 1995 and 2005.

[23] The increase in plant size is partly due to exit, since smaller plants are more likely to exit than larger plants (see Table 1A.3 in the Appendix for further details).

Table 1.2: Pre-Liberalization Plant Characteristics by Year and Group

	1995			1998			2001		
Variables	"0"	"1"	"2"	"0"	"1"	"2"	"0"	"1"	"2"
No. of Employees	7.09	9.94	26.20	6.87	9.62	25.23	7.65	10.87	28.61
Manufacturers	6.55	35.35	100.00	7.35	32.70	80.47	7.95	33.24	77.90
Foreign Assets	3.37	3.87	8.16	n/a	n/a	n/a	2.14	4.20	9.25
Foreign Owned	2.44	5.72	5.48	n/a	n/a	n/a	1.68	4.53	5.36
Exporters	11.15	22.75	45.77	n/a	n/a	n/a	n/a	n/a	n/a
Importers	20.00	42.77	52.26	n/a	n/a	n/a	n/a	n/a	n/a
Renewal Region	27.20	28.05	32.32	27.20	28.13	32.39	27.36	28.08	32.57
Municipality									
Center	39.82	28.93	31.62	39.46	28.51	31.14	38.96	27.40	29.82
Suburban	24.12	30.22	31.78	24.29	30.49	32.07	24.44	30.98	33.11
High-Income	3.53	3.53	2.70	3.57	3.55	2.71	3.56	3.60	2.61
Periurban	7.20	8.72	8.75	7.28	8.82	8.81	7.34	8.97	9.00
Touristic	5.47	2.93	1.26	5.48	2.93	1.28	5.62	2.98	1.30
Ind. Tertiary	9.78	10.51	11.89	9.79	10.58	11.94	9.89	10.69	12.12
Rural Commuter	4.37	6.28	5.84	4.38	6.24	5.92	4.36	6.41	5.74
Rural Mixed	4.89	7.58	5.63	4.92	7.61	5.55	4.99	7.69	5.70
Rural	0.82	1.30	0.53	0.83	1.27	0.58	0.85	1.29	0.60
Region									
Geneva Lake	19.00	16.71	12.86	18.99	16.71	12.90	18.85	16.37	12.46
Espace Midland	21.43	21.77	27.26	21.42	21.76	27.17	21.48	21.70	27.42
North-West	12.43	12.13	13.24	12.42	12.13	13.35	12.34	12.47	13.29
Zürich	18.05	18.40	18.40	18.00	18.29	18.40	17.93	18.02	18.27
East	14.69	15.21	15.66	14.71	15.23	15.65	14.79	15.58	15.93
Central	9.09	10.61	8.85	9.13	10.72	8.81	9.31	10.90	8.90
Tessin	5.31	5.17	3.73	5.31	5.17	3.72	5.30	4.97	3.72
	1995 to 1998			1998 to 2001					
	"0"	"1"	"2"	"0"	"1"	"2"			
Growth Rates	10.66	10.93	10.52	10.88	9.26	11.16			

Notes: Shown are the numbers of employees (in FTEs), the percentage shares, and the growth rates by year and group. "0", "1" and "2" label the groups of non-affected, affected, and strongly affected plants, respectively. The definitions of the variables are provided in Table 1A.4 in the Appendix.

manufacturing plants in the group of strongly affected plants stayed roughly constant above 75 percent. Also, the share of exporting and importing plants continued to be highest in the group of strongly affected firms (around 46 and 54 percent, respectively). Again, there is no clear pattern for the other plant characteristics.

Table 1.3: Post-Liberalization Plant Characteristics by Year and Group

	2005			2008		
Variables	"0"	"1"	"2"	"0"	"1"	"2"
Number of Employees	8.19	11.85	29.47	9.06	13.18	35.15
Manufacturers	7.97	32.71	78.33	8.15	32.24	77.45
Foreign Assets	1.96	3.88	8.91	n/a	n/a	n/a
Foreign Owned	2.13	5.54	6.60	n/a	n/a	n/a
Exporters	10.26	21.63	46.57	n/a	n/a	n/a
Importers	17.15	40.95	54.61	n/a	n/a	n/a
Renewal Region	27.51	28.45	32.86	27.81	28.93	33.08
	2001 to 2005			2005 to 2008		
	"0"	"1"	"2"	"0"	"1"	"2"
Growth Rates	6.64	6.76	6.61	9.40	8.00	11.12

Notes: Shown are the numbers of employees (in FTEs), the percentage shares, and the growth rates by year and group. "0", "1" and "2" label the groups of non-affected, affected, and strongly affected plants, respectively. The definitions of the variables are provided in Table 1A.4 in the Appendix.

The casual comparison of pre- and post-liberalization plant characteristics suggests that the liberalization of trade had a slightly negative (if any) effect on plant growth. Across all groups of plants, the growth rates first declined after liberalization, and then only partially recovered (except for the group of strongly affected firms). However, Tables 1.2 and 1.3 also highlight considerable differences across the groups of plants. When estimating the effect of the Bilateral Agreements I on plant growth based on the DiD and the matching approach, we will account for these differences.

As many of the characteristics shown in Table 1.2 are correlated, Table 1.4 provides the corresponding multivariate analysis based on a probit model comparing the unaffected group to the different affected groups.[24] It shows the key correlates of a plant's probability of being affected by the Bilateral Agreements I. Inspection of Table 1.4 indicates that manufacturing and importing plants with foreign owners have a par-

[24]Later on, it will turn out that this estimation forms one of the 'propensity scores' we are using when estimating the effects corrected for the differences between the various plant groups (see Section 1.4.3).

ticularly high probability of being (strongly) affected. Other plant characteristics are also relevant, but they appear to be less important.

1.4 Econometrics

1.4.1 Empirical Research Design

It is useful to illustrate our approach using the potential-outcome notation which is now standard in the policy evaluation literature (Imbens and Wooldridge, 2009). Specifically, let D denote the binary indicator of trade liberalization (via the Bilateral Agreements I) with $d \in \{0, 1\}$.[25] We are interested in estimating the mean effect of trade liberalization (i.e., switching D from zero to one) on plant size in period t. To do so, let the outcome variable Y_t^d denote the 'potential' plant size that would be realized for some value d in period t (which may be unobservable). Y_t denotes the observed plant size in period t.

We want to answer the policy question whether the plants (strongly) affected by the Bilateral Agreements I benefited from the liberalization of trade. That is, we are interested in estimating the so-called 'average-treatment effect on the treated' (ATET) in period t,

$$\text{ATET}_t = \text{E}(Y_t^1 - Y_t^0 | D = 1). \tag{1.1}$$

It is important to note that, if t denotes a period prior to trade liberalization (e.g., the year 2001), ATET_t measures the anticipation effect of liberalization . If t denotes a period after trade liberalization (e.g., 2005 or 2008), ATET_t measures the medium to longer-run effect of trade liberalization.

The potential-outcome notation clarifies the estimation problem at hand and points to the key issue of causal inference: How can we infer what would have happened (in period t) to the plants affected by the trade liberalization, if the trade liberalization had not taken place? Unfortunately, this 'counterfactual outcome' is never observed. We therefore have to use credible assumptions to impute this outcome.

Our identification strategy exploits the two key advantages of our data base. First, we have data on a very large number of plants—the universe of Swiss plants. This feature allows us to avoid the behavioral restrictions implied (but seldom discussed) by tightly specified parametric models of the linear or non-linear regression type. Second,

[25] Capital letters denote random variables, and small letters denote realizations of random variables.

Table 1.4: Binary Probit Estimates (Matching)

	Groups		
Variable	$\mathbf{0 \to 1}$	$\mathbf{0 \to 2}$	$\mathbf{0 \to (1, 2)}$
Headquarter	0.0503***	0.0003	0.0476***
Single-Plant Firm	0.0295***	0.0085***	0.0332***
Manufacturer	0.3073***	0.2538***	0.3837***
Exporter	0.0178***	0.0262***	0.0336***
Exporter-missing	0.0101**	-0.0009	0.0091*
Importer	0.1881***	0.0300***	0.1894***
Importer-missing	-0.0117**	0.0014	-0.0109**
Foreign Ownership/Assets (Ref.: "Not Owned" and "Not Owner")			
Owns	0.0097*	0.0083***	0.0127***
Owns-missing	-0.0009	0.0024	0.0001
Owned	0.1281***	0.0152***	0.1246***
Owned-missing	0.0055	0.0004	0.0051
Municipality (Reference: Center)			
Suburban	0.0691***	0.0075***	0.0685***
High-Income	0.0448***	0.0011	0.0416***
Periurban	0.0721***	0.0070***	0.0701***
Touristic	-0.0147***	-0.0124***	-0.0222***
Industrial Tertiary	0.0493***	0.0029**	0.0462***
Rural Commuter	0.0971***	0.0091***	0.0925***
Renewal Economic Region	0.0093***	0.0027***	0.0116***
Region (Reference: Zürich)			
Geneva Lake	-0.0051**	-0.0048***	-0.0073***
Espace Midland	-0.0093***	0.0006	-0.0081***
North-West	-0.0168***	-0.0017	-0.0170***
East	-0.0021	0.0014	-0.0024
Central	0.0093***	-0.0004	0.0073**
Tessin	0.0014	-0.0069***	-0.0026
Size (Non-linear)	YES	YES	YES
Observations:	232.334	196.274	240.936

Notes: Coefficients show the average marginal effects and for the dummy variables discrete changes in the quantities of interest. *, **, and *** estimates are significant at the 10%, 5%, and 1% level, respectively. "0", "1" and "2" label the groups of non-affected, affected, and strongly affected plants, respectively. The definitions of the variables and the complete results are presented in Tables 1A.4, 1A.5, and 1A.6, respectively, in the Appendix.

we have panel data over 13 years with measurements in five different periods (1995, 1998, 2001, 2005, and 2008). Thus, we can use the pre-liberalization performance of the plants to find out what would have happened in the absence of trade liberalization.

The key assumption necessary for any partial-equilibrium analysis is that interactions between plants are not relevant for the effect of trade liberalization on plant growth (SUTVA, Rubin (1977)). This assumption implies that one of the potential outcomes Y_t^d is observable for each plant at time t, i.e., $Y_t = dY_t^1 + (1-d)Y_t^0$, with $d \in \{0, 1\}$.[26]

In addition, we assume that the observable covariates X with value x are exogenous (EXOG) in the sense of not being influenced by the liberalization of trade. Similarly, we assume that the pre-liberalization outcomes for 1995 and 1998 were not affected by the liberalization of trade in 2002 (NEPT). We do allow, though, for the possibility that plants anticipated the change in 2001 and already reacted to it.

Finally, since our empirical strategy relies on the use of non-affected plants to impute what would have happened to affected plants in the absence of trade liberalization (for all values of X for which we observe affected or strongly affected plants), we also need to observe plants which are not affected by the liberalization of trade. This assumption is called the common support condition (COSU).

If these assumptions are satisfied, there are two major approaches towards exploiting the panel dimension for non- or semi-parametric identification, namely the matching approach (see the excellent survey by Imbens (2004)) and the differences-in-differences (DiD) approach (see Lechner (2010) for a recent survey).

With the matching approach, we can use the pre-liberalization outcomes as additional control variables. That is, we infer what would have happened to the plants affected by the trade liberalization by using the weighted mean of the outcomes of the non-affected plants. The weights are chosen such that the reweighted distribution of characteristics of the non-affected plants is identical to that observed for the affected plants, with the characteristics including functions of the 1995 and 1998 outcomes. The estimates based on this approach have a causal interpretation if the so-called conditional independence assumption (CIA) holds, that is, if we are able to control for all factors that jointly influence the outcomes and the fact that a plant is affected.[27] This

[26] See Lechner (2010) for a formal definition of this and the following identifying assumptions.
[27] We discuss below whether we think this assumption is credible in our setting.

assumption (in addition to those already mentioned) implies

$$\begin{aligned}
&\mathrm{E}(Y_t^0|X=x, Y_{98}=y_{98}, Y_{95}=y_{95}, D=1) \\
&= \mathrm{E}(Y_t^0|X=x, Y_{98}=y_{98}, Y_{95}=y_{95}, D=0) \\
&= \mathrm{E}(Y_t|X=x, Y_{98}=y_{98}, Y_{95}=y_{95}, D=0).
\end{aligned}$$

Since SUTVA also implies $\mathrm{E}(Y_t^1|D=1) = \mathrm{E}(Y_t|D=1)$, the ATET_t is identified in all periods t because, as can be seen by applying the law of iterated expectations to the second term in the ATET_t in (1.1),

$$\begin{aligned}
&\mathrm{E}(Y_t^0|D=1) \\
&= \mathrm{E}[\mathrm{E}(Y_t^0|X=x, Y_{98}=y_{98}, Y_{95}=y_{95}, D=1)|D=1] \\
&= \mathrm{E}[\mathrm{E}(Y_t|X=x, Y_{98}=y_{98}, Y_{95}=y_{95}, D=0)|D=1].
\end{aligned}$$

The alternative is to adopt a DiD approach and use the pre-liberalization outcomes in a differencing framework, where the key assumption is that the group of non-affected plants is facing the same time trend as the group of (strongly) affected plants would face in the absence of trade liberalization, given specific values of the covariates. This is called the 'common trend' assumption, which can be formalized as follows

$$\begin{aligned}
&\mathrm{E}(Y_t^0 - Y_{98}^0|X=x, Y_{95}=y_{95}, D=1) \\
&= \mathrm{E}(Y_t^0 - Y_{98}^0|X=x, Y_{95}=y_{95}, D=0), \qquad \forall t \in \{2001, 2005, 2008\}.
\end{aligned}$$

Note, in particular, that the outcomes of the year 1998 do not appear as conditioning variables, because otherwise the matching and the DiD approach would be identical.

Furthermore, due the exogeneity assumption applied to the outcomes (NEPT), we have

$$\begin{aligned}
&\mathrm{E}(Y_{98}^{\tilde{d}}|X=x, Y_{95}=y_{95}, D=d) \\
&= \mathrm{E}(Y_{98}|X=x, Y_{95}=y_{95}, D=d), \qquad \forall d, \tilde{d} \in \{0,1\}.
\end{aligned}$$

This assumption requires that we have access to all exogenous variables which could lead to a differential trend for the potential outcome of the non-affected and the (strongly) affected plants in the absence of trade liberalization. We will discuss in Section 1.4.2 below whether this is plausible in our context.

It is easy to show that the common trend assumption together with the assumptions made above (other than CIA), in particular NEPT, is sufficient to identify the missing counterfactual,

$$\begin{aligned}
&\mathrm{E}(Y_t^0|X=x, Y_{95}=y_{95}, D=1) \\
&= \mathrm{E}(Y_t^0|X=x, Y_{95}=y_{95}, D=0) - \mathrm{E}(Y_{98}^0|X=x, Y_{95}=y_{95}, D=0) \\
&\quad +\mathrm{E}(Y_{98}^0|X=x, Y_{95}=y_{95}, D=1) \\
&= \mathrm{E}(Y_t|X=x, Y_{95}=y_{95}, D=0) - \mathrm{E}(Y_{98}|X=x, Y_{95}=y_{95}, D=0) \\
&\quad +\mathrm{E}(Y_{98}|X=x, Y_{95}=y_{95}, D=1).
\end{aligned}$$

Applying the law of iterated expectations in the same way as for matching gives the expression for the ATET_t in terms of observable quantities and thus proves identification.

Comparing the assumptions of the matching and the DiD approach, it becomes clear that the common-trend assumption is in fact a CIA applied to a difference of the outcome variables over time. The advantage of this transformation is that any unobservable variable which affects the counterfactual outcome in all periods in the same way and is additively separable (e.g., an individual fixed effect in a fixed-effects panel regression), is no threat to validity because it is differenced out. This flexibility comes at the cost of a functional-form dependence: A common-trend assumption which is valid for the level of the outcome variable (and thus removes the fixed effect) is not necessarily valid for a monotone but nonlinear transformation (see Lechner (2010), for example). In this sense, identification is functional-form dependent.

The matching approach, on the other hand, uses the outcome variable of 1998 to make the plants comparable on that dimension as well, rather than to take a difference. Although this comparison does not formally remove a fixed effect (even if it is additively separable), it holds for all transformations of the outcome variable. Furthermore, one may argue that conditioning on the outcome 1998 implicitly conditions on the impact of the fixed effect on the future outcome and thus removes (most of) that problem as well.[28]

[28] See Imbens and Wooldridge (2009) for further discussion.

1.4.2 Plausibility of Assumptions

The identification of the causal effect of trade liberalization on plant growth crucially relies on the identifying assumptions. We consider the plausibility of each of them in turn.

First, consider the SUTVA assumption, which requires that one of the potential outcomes Y_t^d is observable for each plant at time t. In our setting, the outcome variable Y_t is plant size in year t, measured by the log of the number of employees in FTEs plus one.[29] In our setting, SUTVA is violated if the liberalization of trade was important enough to affect the outcome for all (i.e., even the non-affected) plants. Our plant classification suggests that the Bilateral Agreements I did not affect all plants. Recall that the impact of agreement (B) on the free movements of persons, which might have affected all industries, was severely limited by so-called 'accompanying measures' ("flankierende Massnahmen"), which prevented major changes in the labor markets of non-affected industries. A crucial element of these measures are quotas which limited the inflow of workers from EU-15 countries until May 31, 2007, and continue to be in place for other EU countries. Given the existence of these quotas and other efforts against the undercutting of wages, we are confident that the remaining interactions between non-affected and other plants (if any) in our sample are negligible.

Next, consider the assumptions that both the covariates X (EXOG) and the outcomes for the years 1995 and 1998 (NEPT) are exogenous. We feel pretty safe in making these assumptions, since the negotiations between the EU (or the EC, respectively) and Switzerland were still well under way in 1998, and the Swiss electorate approved the Bilateral Agreements I only in May 2000 (see Section 1.2.1). It seems quite likely, though, that variables measured in 2001 were affected by the anticipated liberalization of trade. We therefore allow for an anticipation effect in the period from 1998 to 2001.

The common-support assumption (COSU), which requires that there is valid comparison group of non-treated plants for the characteristics x, is not problematic, because there is a very large control group of more than 185,000 plants with considerable variation of x. It is worth noting that this assumption is testable, and our tests suggest no problems.

Proceeding under the notion that these four basic assumptions are satisfied, we now discuss the different additional assumptions needed for the matching and the DiD approach, respectively. Recall that the matching approach additionally imposes the

[29] We add one to the number of employees in FTEs to deal with inactive plants (where the the number of FTEs is zero by definition).

conditional independence assumption (CIA), which requires the control of all factors that jointly determine the outcomes and whether a plant is affected. We are convinced that, thanks to the large set of covariates X available at the plant level (including lagged outcomes from 1995 and 1998), we effectively control for the key factors discussed in the relevant literature. For instance, in addition to a plant's size, which is often viewed as a measure of productivity in the new trade literature, we are able to control for its export and import activity, whether it owns foreign assets or is owned by foreign firms, its geographic location, etc.[30] Nevertheless, we may imperfectly control for some relevant unobservable factors, such as a plant's pre-liberalization integration into European markets. With this in mind, one may argue that the common trend assumption (from 1998 onwards) necessary for the DiD approach is more plausibly satisfied, because by including the growth rate from 1995 to 1998 in the set of control variables, we have already enforced a common trend from 1995 to 1998 by construction.

On balance, it seems difficult to definitely determine which of the two non-nested approaches is more suitable for identifying the causal effect of trade liberalization on plant growth. We will therefore provide the results of both approaches in Section 1.5 below.

1.4.3 Estimation

Having established identification, the next issue is how to perform estimation. The simplest approach, which is still fairly common in some fields, is to specify a parametric model for the relation of the outcome variable with the policy variable and the conditioning variables. For the log of plant size, a linear regression would be a natural choice. For the DiD estimation, one would choose a specification with X and the 1995-1998 growth rate, a time trend, a group indicator, and the interaction of time and group capturing the effect of the liberalization. For the matching estimation, the outcome would be regressed on X and the log of plant size in 1995 and 1998. However, the disadvantage of these simple approaches is that they lead to inconsistent results if these regressions are misspecified. The latter is the case, for instance, if the effect of the liberalization is heterogeneous across plants, and this heterogeneity relates to the characteristics X or plant size in 1995 or 1998.

The alternative is to use semi-parametric matching-type procedures involving the propensity score. The idea is to specify the relation between the membership in a

[30] See Table 1A.4 in the Appendix for a list of the available plant characteristics.

particular group (non-affected, affected, or strongly affected) and the respective control variables using a parametric model, but leaving the relation of the outcome to the control variables free. This approach is common in the program evaluation literature and now spreading to many other fields. It is justified by the additional robustness of not having to specify the relation of the outcomes to the policy variable and the conditioning variables. Clearly, such semi-parametric approaches require large data sets, because giving up functional-form assumptions leads to additional uncertainty in estimation. Yet, the requirement of a large data set is not a problem in our case.

The key insight for deriving practical estimators is that creating 'comparable observations' with respect to the conditioning variables is not necessary, provided that there is comparability with respect to a particular function of those variables called the propensity score

$$p(X) \equiv \Pr(D = 1|X) = \mathrm{E}(D|X). \tag{1.2}$$

Rosenbaum and Rubin (1983) used this property to develop the propensity-score matching estimators. Lechner (2010), among others, shows that the same idea can be used to develop semi-parametric DiD estimators based on propensity-score matching.

In this paper, we estimate the propensity score with a probit model (see Table 1.4 in Section 1.3.4).[31] Then, for the matching estimates, we use a bias-adjusted radius matching procedure as in Lechner et al. (forthcoming), which has superior small-sample properties (Huber et al., 2010). For the DiD matching, an inverse probability estimator is used (Huber et al., 2010; Lechner, 2010).

Due to the particular structure of the plant data, observations for plants which belong to the same company are probably correlated. We approach this problem by devising a bootstrap procedure that independently draws firms (with all their plants in all periods) and basing the inference on the resulting bootstrap distribution of the estimates.

1.5 Results

Table 1.5 reports the results from estimating the ATET_t with the DiD and the matching methodology. The columns indicate the relevant comparison of plant groups. Specifically, we focus on non-affected vs. affected plants ($0 \rightarrow 1$), non-affected vs. strongly affected plants ($0 \rightarrow 2$), and non-affected vs. the pool of affected and strongly affected

[31] The complete results are presented in Tables 1A.5 and 1A.6 in the Appendix.

plants ($0 \to (1,2)$). The rows indicate the years for which the comparison is made (2001, 2005, and 2008, respectively).[32] The table entries report the estimated extra growth rates caused by trade liberalization measured in percentage changes.

Table 1.5: Estimates of the ATET

	Difference-in-Differences			Matching		
Year	$\mathbf{0 \to 1}$	$\mathbf{0 \to 2}$	$\mathbf{0 \to (1,2)}$	$\mathbf{0 \to 1}$	$\mathbf{0 \to 2}$	$\mathbf{0 \to (1,2)}$
2001	-2.00***	-0.60	-1.90***	-0.90	-0.10	-1.30
	(0.50)	(1.30)	(0.60)	(1.10)	(3.90)	(1.30)
2005	1.30*	1.30	1.20*	1.80*	2.20	1.60
	(0.70)	(1.90)	(0.80)	(1.10)	(3.70)	(1.30)
2008	1.30*	4.00**	1.60**	1.80*	5.30	2.20*
	(0.80)	(2.00)	(0.90)	(1.10)	(3.70)	(1.30)

Notes: Outcome variable is log(size+1) in the respective year, with size measured by the number of employees in FTEs. Results are shown in percentage points, which follow from the differences in the average outcomes across groups. Plants which exit in 2005 or 2008 are coded to have size zero.
*, **, and *** estimates are significant at the 10%, 5%, and 1% level, respectively.
Standard errors are in parentheses. Standard errors and inference has been obtained by clustered bootstrap at the firm level using the bootstrap distribution of the effects based on 499 replications.
"0", "1" and "2" label the groups of non-affected, affected, and strongly affected plants, respectively.

Let us first consider the pre-liberalization year 2001. The DiD estimates suggest that the affected plants ($0 \to 1$) experienced a significant reduction in growth by 2 percent in anticipation of the trade liberalization (from 1998 to 2001). The pool of affected and strongly affected plants ($0 \to (1,2)$) also experienced a significant reduction in growth by 1.9 percent, whereas the group of strongly affected plants ($0 \to 2$) alone did not suffer from a significant reduction in growth. The matching estimates are less precise than the DiD estimates, but they suggest a reduction in growth of a similar order of magnitude. These findings are consistent with the notion that, in anticipation of the trade liberalization, the affected plants increased their productivity with the intention of becoming (larger) exporters (López, 2005).[33]

Next, consider the post-liberalization years 2005 and 2008. Both the DiD and the matching estimates suggest that the liberalization of trade increased the growth of the affected plants by 1-2 percent during the first six years after liberalization. The extra

[32]Recall that our identifying assumptions require the outcomes for 1995 and 1998 to be unaffected by the liberalization of trade.

[33]Note, though, that we do not observe productivity at the plant level, so that the anticipation effect needs to be interpreted carefully. Implicitly, this view of the anticipation effect presumes that (non-observable) outputs were non-decreasing during the anticipation phase.

growth of the strongly affected plants during the same time is estimated to be around 4-5 percent. That is, the negative anticipation effect of trade liberalization on plant growth was transitory in nature and turned into a positive effect by 2005.

Summing up, our results suggest that, after a transitory anticipation phase in which plant growth was reduced by up to 2 percent, the Bilateral Agreements I increased the growth of affected plants by 1-2 percent during the first six years after liberalization. The growth of strongly affected plants, in turn, increased by 4-5 percent.

1.6 Conclusion

This paper has proposed a policy evaluation approach towards estimating the effect of trade liberalization on growth. This approach is designed to avoid the well-known econometric difficulties plaguing previous work in this field. In particular, it allows us to identify the direction of causation from trade liberalization on growth.

Viewing a bundle of bilateral agreements between Switzerland and the EU (Bilateral Agreements I) enacted in June 2002 as a plausibly exogenous instance of trade liberalization, we have used data on the universe of Swiss plants from 1995 to 2008 to estimate the effect of trade liberalization on plant growth. Employing both a semi-parametric DiD and a matching approach, we have found the following results:

First, there is evidence for a negative anticipation effect. According to our estimates, the average growth of the affected plants was reduced by up to 2 percent in anticipation of the trade liberalization. This finding is consistent with the notion that firms improve their productivity in anticipation of a market opening.

Second, the negative anticipation effect was turned into a positive effect after liberalization, increasing the average growth of the affected plants by about 1-2 percent during the first six years after enactment. That is, the trade liberalization caused a significant and persistent extra growth of the affected plants.

Our results support the view that trade liberalization has a relevant effect on economic growth. It should be clear, though, that the effect is likely to vary across different instances of trade liberalization and industries affected. It would therefore be interesting to compare our results to similar policy evaluation studies of trade liberalization. A collection of such studies is likely to provide persuasive empirical evidence on the impact of trade liberalization on economic growth.

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1A Appendix to Chapter 1

Table 1A.1: Industry Classification into Groups

	Agreement							Group	Comment(s)
	A	B	C	D	E	F	G		
Mining of Coal and Minerals, Extraction of Oil and Peat									
10 Mining of Coal and Extraction of Peat	0	1	0	0	0	0	0	9	B1
11 Extraction of Crude Oil and Gas	0	1	0	0	0	0	0	9	B1
12 Mining of Uranium and Thorium Ores	0	1	0	0	0	0	0	9	B1
Mining of Iron Ores and Quarrying									
13 Mining of Iron Ores	0	1	0	0	0	0	0	9	B1
14 Other Mining and Quarrying	0	1	0	0	0	0	0	9	B1
Manufacturing of Food									
15 Food and Beverage	1	1	1	0	0	0	0	1	A2, B1,C1,C2
16 Tobacco Products	1	1	1	0	0	0	0	1	A2, B1,C1,C2
Manufacturing of Textiles and Textile Products									
17 Textiles	1	1	0	0	0	0	0	1	A1,A2,B1,X17
18 Apparel	1	1	0	0	0	0	0	1	A1,A2,B1
Leather and Leather Products									
19 Leather Products	1	1	0	0	0	0	0	1	A1,A2,B1
Manufacturing of Wood and Wood Products									
20 Wood, Cork, ...	1	1	0	0	0	0	0	1	A1,A2,B1
Manufacturing of Pulp, Paper and Paper Products									
21 Paper	1	1	0	0	0	0	0	1	A2,B1
22 Publishing, Printing	0	1	0	0	0	0	0	0	A2,B1
Manufacturing of Koke and Refined Petroleum									
23 Koke, Refined Petroleum	0	1	0	0	0	0	0	0	B1
Manufacturing of Chemicals and Chemical Products									
24 Chemicals	1	1	1	0	0	0	0	1	A1,B1,C2
Manufacturing of Syntheticals and Synthetical Products									
25 Syntheticals	1	1	0	0	0	0	0	1	A1,B1
Manufacture of Non-Metalic Mineral Products									
26 Glass, Ceramic, etc.	1	1	0	1	0	0	0	0	A2,B1,X26
Production, Manufacturing of Metal and Metal Products									
27 Production of Metal	0	1	0	1	0	0	0	0	B1,X26
28 Metal Products	0	1	0	1	0	0	0	0	B1,X26
Manufacturing Systems Engeneering									
29 Machinery, Equipment	1	1	0	1	0	0	0	2	A1,A2,D1
Manufacturing of Business Machines									
30 Business Machines	1	1	0	1	0	0	0	2	A1,A2,B1,D1
31 Electric Machinery	1	1	0	1	0	0	0	2	A1,A2,B1,D1
32 Radio, TV, Communication Apparatus	1	1	0	0	0	0	0	2	A1,A2,B1
33 Med. Apparatus, Precision Instruments	1	1	0	1	0	0	0	2	A1,A2,B1
Vehicle Manufacturing									
34 Automobiles and Parts of Cars	1	1	0	1	0	0	0	2	A1,B1,D1
35 Other Vehicles	1	1	0	1	0	0	0	2	A1,B1,D1

Table 1A.1: Industry Classification into Groups (continued)

		Agreement							Group	Comment(s)
		A	B	C	D	E	F	G		
Manufacturing of Furniture, Jewellery, Musical Instruments										
36	Furniture, Jewellery, etc.	1	1	0	0	0	0	0	1	A1,B1
37	Recyling	0	1	0	0	0	0	0	0	B1
Electricity, Gas and Water Supply										
40	Energy Supply	0	1	0	1	0	0	0	0	B1,D2
41	Water Supply	0	1	0	1	0	0	0	0	B1,D2
Construction Industry										
45	Construction	0	1	0	1	0	0	0	0	B1,D2
Retail and Wholesale Trade, Repair of Automobiles										
50	Trade of parts and complete Vehicles Repair and Maintenance	1	1	0	0	0	0	0	1	A1,B1
51	Wholesale and Commission Trade	1	1	0	0	0	0	0	1	B1,X51
52	Retail Trade	0	1	1	0	0	0	0	0	B1,C1,X52
Lodging and Restaurants										
55	Lodging and Restaurants	0	1	0	0	0	0	0	0	B1
Transportation and Communication										
60	Land Transportation and Pipelines	0	1	0	0	1	0	0	0	B1,E1
61	Water Transportation	0	1	0	0	0	0	0	0	B1
62	Air Transportation	0	1	0	0	0	1	0	0	B1,F1
63	Auxiliary Transport Activities	0	1	0	0	1	1	0	0	B1,E1,F1
64	Post and Telecommunications	0	1	0	0	0	0	0	0	B1
Credit Institutions and Insurances										
65	Commercial and Central Banks, Fonds	0	1	0	0	0	0	0	0	B1
66	Insurance Companies	0	1	0	0	0	0	0	0	B1
67	Banking Business Activities	0	1	0	0	0	0	0	0	B1
Real Estate and Housing, Renting of Good and Chattels										
70	Real Estate and Housing	0	1	0	0	0	0	0	0	B1
71	Renting of Goods and Chattels	0	1	0	0	0	0	0	0	B1
72	Data Processing and Data Bases	0	1	0	1	0	0	0	0	B1,D1
73	Research and Development	0	1	0	0	0	0	1	0	B1,G
74	Other Business Activity	0	1	0	0	0	0	0	0	B1
Public Administration, Social Insurance										
75	Public Administration, Social Insurance	0	0	0	0	0	0	0	9	
Education										
80	Education	0	0	0	0	0	0	0	9	
Health Care, Welfare										
85	Health Care, Welfare	0	0	0	0	0	0	0	9	
Other Public or Private Services										
90	Sewage and Waste Treatment	0	1	0	1	0	0	0	0	B1,D1
91	Lobby, Religious Organizations	0	1	0	0	0	0	0	0	B1
92	Culture and Sports Activities	0	1	0	0	0	0	0	0	B1
93	Other Services	0	1	0	0	0	0	0	0	B1
Private Households Goods and Services										
95	Households with Employees	0	1	0	0	0	0	0	0	B1
96	Manufacturing for own use	0	1	0	0	0	0	0	0	B1
97	Services for own use	0	1	0	0	0	0	0	0	B1

Notes: "0", "1", "2" and "9" label the groups of non-affected, affected, strongly affected and excluded plants, respectively. You can find the "comments" below this table.

Comments:

(A1) The MRA explicitly covers the following industries: (1) Machinery; (2) Personal protective equipment; (3) Toys; (4) Medical devices; (5) Gas appliances and boilers; (6) Pressure vessels; (7) Telecommunications terminal equipment; (8) Equipment and protective systems intended for use in potentially explosive atmospheres; (9) Electrical equipment and electromagnetic compatibility; (10) Construction plants and equipment; (11) Measuring instruments and prepackages; (12) Motor vehicles; (13) Agricultural and forestry tractors; (14) Good laboratory practice (GLP); (15) Medical products GMP Inspection and Batch Certification.

(A2) The MRA does not cover all "packing" from either country. Since the MRA allows to ask for conformity in a single inspection authority, it substantially eases the proof of conformity.

(B1) The *agreement on the free movement of persons* ensures equal treatment of Swiss and EU citizens in taking up residence and work. However, the inflow of workers from EU-15 countries continued to be limited by quotas until May 31, 2007, and it is still limited for other EU countries. It is thus reasonable to assume that, at least until summer 2007, this agreement had virtually no impact on Swiss industries.

(C1) The *agreement on agricultural products* liberalizes the cheese market (free trade since June 2007) and simplifies trade in other agricultural products. The treaty should be expected to influence all industries dealing with agricultural products.

(C2) The *agreement on agricultural products* removes technical trade barriers in the following fields: (1) Crop protection; (2) Animal feed; (3) Viniculture; (4) Spirits and flavored drinks containing wine; (5) Organic products and foodstuff; (6) Recognition of conformity checks for fruit and vegetables subject to marketing standards; (7) Veterinary and breeding measures applicable to trade in living animals and animal products.

(D1) The first chapter of the *agreement on public procurement* extends the WTO rules and subjects public authorities and bodies at the district and municipality level to compulsory tendering.

(D2) The second chapter of the *agreement on public procurement* subjects licensed firms (e.g., telecommunications and railway operators) to compulsory tendering.

(E1) The *agreement on ground transportation* increases the maximum weight limit for heavy trucks from 28 to 40 tonnes and prescribes the introduction of a Pigouvian tax on heavy vehicles, which provides incentives for moving transalpine freight from road to rail.

(F1) The *agreement on civil aviation* stipulates reciprocal access to aviation markets (including landing rights).

(G) The *agreement on scientific and technological cooperation* regulates the participation of Swiss research institutions and individual in EU programs.

(X17) Not affected by agreement D (no evidence for tendering).

(X26) Affected by agreement D (public tendering is observed).

(X51) Affected by agreement A (cf. A1 and A2 above).

(X52) Affected by agreement C, because agricultural products are imported more easily (cf. C1 above).

Table 1A.2: Sample Size

	Year				
	1995	1998	2001	2005	2008
Complete Data Base	372,782	379,330	385,074	375,167	389,165
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Eliminated Plants					
Non-Private	37,892	35,361	34,073	33,050	32,747
	(10.16)	(9.32)	(8.85)	(8.81)	(8.41)
Mining Industries etc.	34,672	34,560	36,283	35,462	37,156
	(9.30)	(9.11)	(9.42)	(9.45)	(9.55)
Not Active in 1995 and 1998	59,282	68,473	119,107	147,172	175,998
	(15.90)	(18.05)	(30.93)	(39.23)	(45.22)
Final Sample	240,936	240,936	195,611	159,483	143,264
	(64.63)	(63.52)	(50.80)	(42.51)	(36.81)

Notes: Shown is the number and share of plants by year. The final sample consists of 240,936 plants. In the final sample all plants observed in 2001 and later are already observed in 1995 and 1998. Estimation is based on 240,936 plants with employment levels for plants which were closed after 1998 set to zero.

Table 1A.3: Number of Plants by Group, Size, and Year

		Year				
Group	Size	1995	1998	2001	2005	2008
not affected ("0")	Micro (0-9)	160,107	160,998	127,559	101,476	88,715
		(100.00)	(100.56)	(79.67)	(63.38)	(55.41)
	Small (9-49)	24,161	23,424	21,363	19,051	18,862
		(100.00)	(96.95)	(88.42)	(78.85)	(78.07)
	Medium (49-249)	3139	2,991	2,911	2,649	2,755
		(100.00)	(95.29)	(92.74)	(84.39)	(87.77)
	Large (249+)	265	259	277	230	253
		(100.00)	(97.74)	(104.53)	(86.79)	(95.47)
	Total (group "0")	187,672	187,672	152,110	123,406	110,585
		(100.00)	(100.00)	(81.05)	(65.76)	(58.92)
affected ("1")	Micro (0-9)	36,317	36,477	28,975	23,248	20,457
		(100.00)	(100.44)	(79.78)	(64.01)	(56.33)
	Small (9-49)	6,850	6,726	5,982	5,545	5,412
		(100.00)	(98.19)	(87.33)	(80.95)	(79.01)
	Medium (49-249)	1,350	1,316	1,214	1,079	1,096
		(100.00)	(97.48)	(89.93)	(79.93)	(81.19)
	Large (249+)	145	143	154	136	148
		(100.00)	(98.62)	(106.21)	(93.79)	(102.07)
	Total (group "1")	44,662	44,662	36,325	30,008	27,113
		(100.00)	(100.00)	(81.33)	(67.19)	(60.71)
strongly affected ("2")	Micro (0-9)	5,960	5,994	4,748	3,933	3,433
		(100.00)	(100.57)	(79.66)	(65.99)	(57.60)
	Small (9-49)	1,778	1,748	1,585	1,413	1,366
		(100.00)	(98.31)	(89.15)	(79.47)	(76.83)
	Medium (49-249)	691	688	686	580	602
		(100.00)	(99.57)	(99.28)	(83.94)	(87.12)
	Large (249+)	173	172	157	143	165
		(100.00)	(99.42)	(90.75)	(82.66)	(95.38)
	Total (group "2")	8,602	8,602	7,176	6,069	5,566
		(100.00)	(100.00)	(83.42)	(70.55)	(64.71)
	Total (all groups)	240,936	240,936	195,611	159,483	143,264
		(100.00)	(100.00)	(81.19)	(66.19)	(59.46)

Notes: The number in brackets shows the percentage relative to the reference year 1995. The classification of plants into groups is based on Table 1A.1.

Table 1A.4: Definitions of the Variables

Variable	Description
Headquarter	Plant is a headquarter of a Multi-Plant Company.
Single-Plant Firm	Plant is a Single-Plant Company.
Companion	Plant is a companion plant of a Multi-Plant Company.
Manufacturer	Plant is in the manufacturing sector.
Exporter	Plant belongs to a firm which exports to foreign markets.
Exporter-missing	Survey question is not asked (1998, 2001 and 2008) or not answered.
Importer	Plant belongs to a firm which imports from abroad.
Importer-missing	Survey question is not asked (1998, 2001 and 2008) or not answered.
Renewal Economic Region	Region is eligible for public funds supporting regional development.
Size	Plant's employment is measured in FTEs.
Foreign Ownership/Assets	
Owns	Plant belongs to a firm which (partly) owns foreign assets.
Owns-missing	Survey question is not asked (1998 and 2008) or not answered.
Owned	Plant belongs to a firm which is (partly) owned by foreign capital.
Owned-missing	Survey question is not asked (1998 and 2008) or not answered.
Municipality	
Center	Central municipality of a large agglomeration in a metropolitan region.
Suburban	Suburban or job-rich (non-central) municipality in a metropolitan region.
High-Income	Real income per resident exceeds some specific threshold in the region.
Periurban	Municipality in an agglomeration (neither suburban nor high-income).
Touristic	Municipality featuring a high number of touristic overnight stays.
Industrial Tertiary	Municipality with a high production of industrial goods and services.
Rural Commuter	Municipality located outside an agglomeration with a high share of commuters.
Rural Mixed	Municipality with a relatively high share of agrarian production.
Rural Municipality	Municipality with high share of agrarian production.
Geographic Region	*Canton*
Zürich	Zürich
Geneva Lake	Geneva, Vaud, Valais
Espace Midland	Bern, Fribourg, Jura, Neuchâtel, Solothurn
North-West	Aargau, Basel-Country, Basel-City
East	Appenzell Inner-Rhodes, Appenzell Outer-Rhodes, Glarus, Graubünden, St. Gallen, Schaffhausen, Thurgau
Central	Lucerne, Nidwalden, Obwalden, Schwyz, Uri, Zug
Tessin	Ticino

Notes: Municipalities and geographic regions are classified by the Swiss Federal Statistical Office and documented in Schuler et al. (2005).

Table 1A.5: Binary Probit Estimates (Matching)

	Coefficients			Average Marginal Effects		
Variable	$\mathbf{0 \to 1}$	$\mathbf{0 \to 2}$	$\mathbf{0 \to (1,2)}$	$\mathbf{0 \to 1}$	$\mathbf{0 \to 2}$	$\mathbf{0 \to (1,2)}$
Headquarter	0.2325***	0.0057	0.2102***	0.0503***	0.0003	0.0476***
Single-Plant Firm	0.1311***	0.1579***	0.1433***	0.0295***	0.0085***	0.0332***
Manufacturer	0.9930***	1.7734***	1.1850***	0.3073***	0.2538***	0.3837***
Exporter	0.0744***	0.3900***	0.1342***	0.0178***	0.0262***	0.0336***
Exporter-missing	0.0428**	-0.0160	0.0375*	0.0101**	-0.0009	0.0091*
Importer	0.6846***	0.4520***	0.6785***	0.1881***	0.0300***	0.1894***
Importer-missing	-0.0510**	0.0243	-0.0459**	-0.0117**	0.0014	-0.0109**
Foreign Ownership/Assets (Reference: "Not Owned" and "Not Owner", respectively)						
Owns	0.0409*	0.1347***	0.0521***	0.0097*	0.0083***	0.0127***
Owns-missing	-0.0038	0.0404	0.0004	-0.0009	0.0024	0.0001
Owned	0.4685***	0.2350***	0.4527***	0.1281***	0.0152***	0.1246***
Owned-missing	0.0235	0.0073	0.0210	0.0055	0.0004	0.0051
Municipality (Reference: Center)						
Suburban	0.2809***	0.1268***	0.2723***	0.0691***	0.0075***	0.0685***
High-Income	0.1804***	0.0186	0.1647***	0.0448***	0.0011	0.0416***
Periurban	0.2830***	0.1156***	0.2708***	0.0721***	0.0070***	0.0701***
Touristic	-0.0646***	-0.2452***	-0.0951***	-0.0147***	-0.0124***	-0.0222***
Industrial Tertiary	0.1990***	0.0498**	0.1829***	0.0493***	0.0029**	0.0462***
Rural Commuter	0.3688***	0.1471***	0.3478***	0.0971***	0.0091***	0.0925***
Rural Mixed	0.4021***	0.0871***	0.3647***	0.1067***	0.0052***	0.0973***
Rural Municipality	0.4207***	-0.0005	0.3661***	0.1136***	0.0000	0.0985***
Renewal Region	0.0396***	0.0467***	0.0480***	0.0093***	0.0027***	0.0116***
Region (Reference: Zürich)						
Geneva Lake	-0.0219*	-0.0873***	-0.0308***	-0.0051**	-0.0048***	-0.0073***
Espace Midland	-0.0402***	0.0103	-0.0342***	-0.0093***	0.0006	-0.0081***
North-West	-0.0738***	-0.0298	-0.0720***	-0.0168***	-0.0017	-0.0170***
East	-0.0092	0.0240	-0.0102	-0.0021	0.0014	-0.0024
Central	0.0395***	-0.0076	0.0301**	0.0093***	-0.0004	0.0073**
Tessin	0.0058	-0.1280***	-0.0108	0.0014	-0.0069***	-0.0026
Size (Non-linear)	YES	YES	YES	YES	YES	YES
Constant	-1.8170***	-2.7948***	-1.7785***	—	—	—
Observations:	232.334	196.274	240.936	232.334	196.274	240.936

Notes: The dependent variable is binary; it is 0 for non-treated plants and 1 for the treated plants in groups "1" or "2", respectively. *, **, and *** estimates are significant at the 10%, 5%, and 1% level, respectively. The sizes of firms and plants are measured in full time employment units and the coefficients are left out here for the purpose of clarity.

Table 1A.6: Binary Probit Estimates (Difference-in-Differences)

	Coefficients			Average Marginal Effects		
Variable	$\mathbf{0 \to 1}$	$\mathbf{0 \to 2}$	$\mathbf{0 \to (1,2)}$	$\mathbf{0 \to 1}$	$\mathbf{0 \to 2}$	$\mathbf{0 \to (1,2)}$
Growth (1995/1998)	-0.0007	-0.0072	-0.0011	-0.0002	-0.0004	-0.0003
Headquarter	0.3841***	0.1306***	0.3701***	0.0796***	0.0071***	0.0805***
Single-Plant Firm	0.1271***	0.1299***	0.1319***	0.0288***	0.0071***	0.0308***
Manufacturer	0.9975***	1.7783***	1.1923***	0.3109***	0.2570***	0.3888***
Exporter	0.0883***	0.3955***	0.1498***	0.0213***	0.0268***	0.0379***
Exporter-missing	0.0494**	-0.0077	0.0441**	0.0118**	-0.0004	0.0108**
Importer	0.6730***	0.4421***	0.6676***	0.1849***	0.0293***	0.1865***
Importer-missing	-0.0605***	0.0222	-0.0547***	-0.0139***	0.0013	-0.0130***
Foreign Ownership/Assets (Reference: "Not Owned" and "Not Owner", respectively)						
Owns	-0.0991***	0.1109***	-0.0754***	-0.0224***	0.0067***	-0.0177***
Owns-missing	-0.0092	0.0429	-0.0051	-0.0021	0.0025	-0.0012
Owned	0.4458***	0.1941***	0.4278***	0.1217***	0.0123***	0.1176***
Owned-missing	0.0270	0.0078	0.0245	0.0064	0.0004	0.0059
Municipality (Reference: Center)						
Suburban	0.2784***	0.1254***	0.2705***	0.0688***	0.0074***	0.0684***
High-Income	0.1750***	0.0191	0.1593***	0.0436***	0.0011	0.0404***
Periurban	0.2802***	0.1158***	0.2686***	0.0718***	0.0070***	0.0699***
Touristic	-0.0651***	-0.2513***	-0.0963***	-0.0149***	-0.0127***	-0.0225***
Industrial Tertiary	0.1932***	0.0459*	0.1773***	0.0480***	0.0027*	0.0449***
Rural Commuter	0.3663***	0.1454***	0.3454***	0.0969***	0.0090***	0.0923***
Rural Mixed	0.3985***	0.0835***	0.3612***	0.1063***	0.0050**	0.0968***
Rural Municipality	0.4179***	0.0020	0.3633***	0.1134***	0.0001	0.0983***
Renewal Region	0.0392***	0.0445***	0.0472***	0.0092***	0.0026***	0.0115***
Region (Reference: Zürich)						
Geneva Lake	-0.0156	-0.0824***	-0.0245**	-0.0037	-0.0046***	-0.0059**
Espace Midland	-0.0413***	0.0061	-0.0355***	-0.0096***	0.0004	-0.0085***
North-West	-0.0732***	-0.0309	-0.0713***	-0.0168***	-0.0018	-0.0169***
East	-0.0097	0.0182	-0.0111	-0.0023	0.0011	-0.0027
Central	0.0418***	-0.0122	0.0319***	0.0099***	-0.0007	0.0078**
Tessin	0.0105	-0.1283***	-0.0064	0.0025	-0.0069***	-0.0015
Constant	-1.8573***	-2.8151***	-1.8170***	—	—	—
Observations:	232.334	196.274	240.936	232.334	196.274	240.936

Notes: The dependent variable is binary; it is 0 for non-treated plants and 1 for the treated plants in groups "1" or "2", respectively. *, **, and *** estimates are significant at the 10%, 5%, and 1% level, respectively.

Chapter 2

Estimating the (causal) Effect of Trade Liberalization on Exit

2.1 Introduction

The effects of trade liberalization on an economy have been widely studied in the economic literature for a long time. The traditional trade theory surveyed by Bhagwati (1964) focuses (for example in Ricardo's model) on comparative advantages in order to explain the gains from specialization across countries. The new trade theory goes beyond a country level analysis, and explains empirical patterns by industry level differences (Krugman, 1981). Furthermore, the new-new trade theory (Melitz, 2003; Bernard et al., 2003) introduces heterogeneity at the firm level, which predicts essentially two outcomes in response to a more open trade policy: First, there occurs a reallocation of market shares towards the more productive firms. Second, the least productive firms exit the market. Taken together, these two effects initiate substantial structural transformations of the economy. The first prediction was investigated by Buehler et al. (2011), whereas the current paper is concerned with the second aspect.

Based on a unique data set which includes plant-level observations covering the whole Swiss economy for the years 1995 to 2008, I analyze the effects of trade liberalization on a change in exit rates according to the predictions of the new-new trade theory. Therefore in my empirical analysis, I exploit a substantial reduction of the barriers to trade between Switzerland and the European Community which is part of the so-called Bilateral Agreements I (BAI) enacted in 2002. This allows applying a conditional difference-in-differences strategy for the empirical investigation and is a rare

case of a plausible exogenous variation with observations before and after a natural experiment. In this respect, it is more reliable than, than for example, Pavcnik (2002), which lacks any data preceding the trade policy reform.

In particular, the identification strategy relies on this natural experiment, and allows comparing exit rates of firms for affected and non-affected industries before and after the trade liberalization. For instance, the machinery industry is classified as affected because its products are subject to a Mutual Recognition Agreement (MRA) belonging to the BAI. Another example is the recycling industry, which is not affected by any of the agreements. This selectivity of the BAI with regard to different industries forms the basis for assigning each plant to the groups of affected or non-affected plants. For this categorization, the Swiss equivalent of the Standard Industrial Classification (SIC) is used at the two-digit level. A key assumption for identification, which is the common trend (CT), assumes, that in the absence of the policy change the difference between affected and non-affected plants would be constant. Subsequently, the estimated change in the difference between the two groups is the effect that is attributed to the agreements. Since it is possible that the two groups differ in characteristics which jointly affect the selection and the trends of exit rates (which is the outcome variable), I address this potential drawback by including the relevant observable plant characteristics in the estimation procedure. The CT assumption is assumed to be conditionally valid, therefore, this is called the conditional difference-in-differences approach. In other words, the different groups are comparable through an adjustment of their distribution of characteristics.

The results indicate a negative effect on the exit rate for all post-liberalization periods. More specifically, after the enactment of the BAI (in the year 2002), there is an absolute reduction of the exit rate by roughly 1.3 percentage points for the first three years. This short term change is substantial, considering that the average level of the exit rate is about 20% (for a three year period). In the longer term (i.e., five to eight years after the implementation), the exit rate is reduced by 1.5 percentage points, indicating the persistence of the effect. These findings are robust for the parametric and the semi-parametric specifications of the model. Moreover, one year before the enactment, the results show a reduction of exit rates, too. This is called the anticipation effect because it appears immediately after the referendum is agreed. Furthermore, the new-new trade theory suggests heterogeneous effects depending on the productivity levels (cf. Melitz (2003)). Admittedly, the necessary direct productivity measures are not available, but in this literature small firms are small because they have high marginal

costs. Hence, I use a plant's size as a proxy for its productivity and split the sample at the median between small and large plants. In the short term, large establishments reduce their average exit rate by almost 1.0 percentage points compared to 1.5 percentage points for the small ones. In the long term, the two subsamples exhibit only marginal differences. Hence, the adjustment time, which is the period until the new level of survival is observed, is shorter for smaller than for larger plants. A potential explanation is that smaller firms are more flexible and benefit more rapidly from the additional demand opportunities.

This paper contributes to analyzing the predictions derived from the new-new trade theory for the results of trade liberalization. In this context, it is the second paper in a series, and continues the work of Buehler et al. (2011), who focus on economic growth. The present paper extends the analysis to the exit behavior of firms. A particularity and joint contribution of both studies is the use of a causal identification strategy which is only possible due to the extensive data set and the exploitation of a plausible exogenous policy change. The data is from Switzerland, including plants of all sizes from the manufacturing and the service sectors. This distinguishes this series of papers from the evidence provided by many previous studies, which are often restricted to developing countries, large plants, or specific sectors (Tybout and Westbrook, 1995; Pavcnik, 2002; Bernard et al., 2006). At the same time, this micro-econometric study is representative for a small, open, developed economy.

A finding of this study is that liberalized trade is one important determinant explaining a (permanent) shift in the exit rate. In particular, I find that liberalized trade decreases the exit rate. This evidence conflicts with the new-new trade theory, which predicts the closure of the least productive firms due to an increased productivity threshold which comes from the trade liberalization. The proposed channels are greater competition either in the input (Melitz, 2003) or the product (Bernard et al., 2003; Melitz and Ottaviano, 2008) markets. This results in a new productivity distribution where only the more productive firms stay in the market. The implication that the least productive firms exit is found in recent studies (Pavcnik, 2002; Bernard et al., 2006). Given this evidence for a different firm distribution, the assumption to use an exogenous constant exit rate is rather strict (Melitz, 2003). If only the most productive firms remain, one could imagine a change in the exit rate. In this analysis, my findings suggest that the exit rate is affected by trade liberalization, indicating the need for further research on endogenizing it. A similar argument as to why exit rates and trade liberalization might be related is made by Brander (1995) and Zingales (1998). They

argue that higher profits allow reducing debts (lower leverage), which increases the survival probability in response to exogenous shocks. Higher profits for the remaining (most productive) firms come from a larger market share (Melitz, 2003), the creation of additional trade (Trefler, 2004; Bustos, 2011), and through better access to the foreign market (Baggs, 2005).

This analysis adds to the existing literature on the determinants explaining entry and exit surveyed by Caves (1998). Based on an investigation conducted by Dunne et al. (1988), the early evidence showed high correlation between entry and exit rates. Moreover, that study emphasized already that failure rates decline with size and age. The theory of learning, which predicts that over time only low cost firms remain in the market, is a widely accepted explanation (Jovanovic, 1982). More recent studies have identified further determinants. For example, there are the legal form (Harhoff et al., 1998), industry affiliation (Agarwal and Audretsch, 2001), and geographic location (Buehler et al., 2010). Another recent investigation finds that higher productivity decreases the probability of exit (Eslava et al., 2006). This evidence in the context of the new-new trade theory, which predicts that liberalized trade has structural effects on the productivity distribution in the economy, is consistent with my analysis, which claims that liberalized trade is a decisive factor explaining a decrease in the exit rate. Note, however, that a direct measure for productivity is unobserved by me making a direct inference on exit impossible.

The remainder of the present paper is structured as follows. Section 2.2 provides an introduction to Swiss trade policy. Section 2.3 describes the data set and explains the classification. Section 2.4 discusses the empirical research design, the plausibility of the assumptions, and the estimation approach. Section 2.5 presents the empirical results and Section 2.6 concludes.

2.2 Swiss Trade Policy

Switzerland is a small country and at the same time cultural diverse, illustrated for example by the existence of four official languages. A direct democracy is practiced, which allows balancing political interests. This system includes elements such as national referenda. These are obligatory for important political decisions and guarantee the participation of the society as a whole. Switzerland is located in the center of the European continent and shares borders with Germany, France, Italy, and Austria. The existing cultural diversity is an advantage that allows a good understanding of a cus-

tomer's needs in these markets. According to EUROSTAT (2009), products exported from Switzerland to the European Union (EU) had a total value of more than 73 billion EUR in the year 2009. In particular, firms deliver goods such as chemicals (EUR 24.5 bn), machinery (EUR 14.6 bn), and manufactured articles or goods (EUR 19.3 bn). Imports from the EU account for more than 88 billion EUR. The two most important categories are again machinery (EUR 24.5 bn) and chemicals (EUR 16.7 bn). From an EU perspective, Switzerland is its fourth important trading partner, behind the United States, China, and Russia. Responsible for two thirds of the total Swiss trade volume, the EU is Switzerland's largest trading partner. These facts show that the exchange of specialized high quality products such as machinery is beneficial in both directions.

This intensified exchange is a result of the long tradition of bilateral contractual agreements surveyed by Buehler et al. (2011). An exception is the agreement on joining the European Communities as a full member, which was proposed by the Swiss government. The voters prevented this membership in a referendum in the year 1992. The reason was not a rejecting of the necessity for a stronger cooperation, but the limitations implied on Swiss sovereignty. As a consequence, both partners continued their trade relations based on bilateral contractual agreements. This process led to the negotiation of a bundle of agreements (Bilateral Agreements I). In another referendum, in May 2000, the voters approved these contracts, which have been in effect since June 1, 2002. It is the single most important bundle of agreements and marked an important step for a closer integration of both economies. There are seven agreements which regulate the following areas: Technical Barriers to Trade (A), Free Movements of Persons (B), Agricultural Products (C), Public Procurement (D), Ground Transportation (E), Civil Aviation (F), and Scientific and Technological Cooperation (G). Of particular interest is the agreement on Technical Barriers to Trade, which is a so-called Mutual Recognition Agreement (MRA). It stipulates the mutual recognition of conformity tests which confirm that a product is in accordance with applicable regulations. The company is only allowed to sell a product after approval. This MRA substantially simplifies the trade in a large variety of products, such as machines, printers, medical products, motor vehicles, tractors, measuring instruments, and telecommunication devices. According to the Integration Office (2009), it leads to a broader variety of available products and to savings in the export industries of between 200 and 500 million CHF per year. With regard to Swiss trade policy, it is the most important agreement concluded in the observed time period.

2.3 Data

The data consist of the five latest waves of the Swiss Business Census, covering the years 1995, 1998, 2001, 2005, and 2008. This is a mandatory survey compiled by the Swiss Federal Statistical Office to obtain a complete inventory count of all Swiss economic production units with more than 20 hours weekly working time, excluding the agricultural sector. The survey collects information on economic, social, and geographical characteristics which are explained in more detail in Table 2A.4 in the Appendix. The available data is remarkably rich because it covers small plants, the manufacturing as well as the service sectors, and a period of 13 years. Moreover, each production unit is assigned a unique identification number. Based on this identifier, it is possible to observe all exits at the plant level.

2.3.1 Sample

For analyzing the effect of trade liberalization, I consider profit-oriented companies only. In a second step, associations and clubs as well as churches, embassies and international organizations are excluded, as they are not representative of the effects of trade policies. In addition, I remove industries with a negligible amount of observations (e.g., mining) or dominated by public administration (e.g., education, health care, or welfare). As a final step the sample is cleaned from coding mistakes. These refer to some establishments which reappear with the same identification number after they were shut down for one or more periods. According to the Swiss Federal Statistical Office, the plant identification number is assigned only once at entry and disappears if this plant is closed. Therefore, the observation of plants that reappear are mistakes under the sampling rules, and excluded. Table 2A.2 in the Appendix shows how the sample size is reduced by each of these restrictions. In total, the final sample consists of almost 80% of the complete data base, which contains about 300,000 plants for each year of observation.

2.3.2 Definitions

First of all, the event of 'exit' is defined as a plant's disappearing from one surveyed year to the next. This procedure is valid because each plant is assigned a unique identification number on entry. Including all establishments in Switzerland, the data provides a comprehensive picture of plant closures.

Table 2.3.1: Definition of Periods

Period t	Interval	Name	Implementation of the BAI
$t = 0$	1995 to 1998	Baseline Period	Before / Ongoing Negotiations
$t = 1$	1998 to 2001	Anticipation Period	Approved Referendum
		Transition from Pre- to Post-Liberalization Periods	
$t = 2$	2001 to 2005	Post-Liberalization (Short Term)	Enactment (Implementing the MRA)
$t = 3$	2005 to 2008	Post-Liberalization (Long Term)	Post-Implementation

Note: The intervals vary between 3 and 4 years which is accounted for in the estimation.

Based on the five waves, the survey offers the possibility of investigating the evolution of exit rates for four different time periods. In Table 2.3.1, these are labeled according to the implementation of the BAI. Hence, the data covers two periods before the liberalization, i.e., exit rates between 1995 and 1998 ($t = 0$, baseline) and between 1998 and 2001 ($t = 1$, anticipation). In addition, there are two post-liberalization periods which allow calculating exit rates between 2001 and 2005 ($t = 2$, short term) and between 2005 and 2008 ($t = 3$, long term).

The outcome which I use to measure the effect of the reduced trade barriers (due to the BAI in 2002) is defined as the difference between exit rates in periods $t = 0$ and $t = 2$, which reflects a short term perspective. The long(er) term is obtained by using the exit rates for periods $t = 0$ and $t = 3$.

Finally, the analysis rests upon the binary classification of plants into 'non-affected' or 'affected' by the BAI. The assessment is based on the wording and additional explanatory public documents. Based on this judgement, each industry is assigned to one of these two groups. For instance, the machinery industry (SIC 29) is affected by agreement (A). In particular, it is affected by the MRA stipulating the mutual recognition of conformity tests and facilitating regulations on packing conformity. This agreement is especially intended for the machinery industry. However, there is, besides, the agreements (B) and (D). As a result, the machinery industry is affected by three out of the seven agreements, and is assigned to the affected group. Another example is the recycling industry (SIC 37), affected by agreement (B). Admittedly, this agreement on free movement concerns (more or less) all industries, making it less decisive for a plant to be regarded as affected for two reasons. First, it becomes irrelevant if it affects all industries in the same way, which is an advantage of the DiD by differencing away a potential effect between the groups. Second, even if not all industries are affected in

the same way, quotas guarantee a minor impact of this agreement at least until 2007. In addition, and with regard to the recycling industry (SIC 37), none of the other six agreements affects this industry, so it can be classified as non-affected. These two examples are typical for this binary classification[1] which is the same as that used in Buehler et al. (2011) (apart from the fact that the affected plants are not additionally split up into weakly or strongly affected ones).

2.3.3 Descriptive Statistics

To illustrate the classification explained in the previous subsection, Table 2.3.2 shows how the observations are split into affected and non-affected plants. The last two columns present, respectively, the relative shares within each group and across the sample. In the total sample, the service sector has a share of 85.07%. Within the group of affected plants, the service sector has 55.20% (35,378 observations), which is composed of only two large industries. Those are the trade vehicles (22.37%), and wholesale trade and commission trade (32.83%). In the total sample, the manufacturing sector has a share of 14.93%. Regarding the affected plants, the relative share of manufacturing is, with 44.80% (28,712 observations), about three times larger. This dominance of manufacturers is a distinct feature and highlights a considerable difference between the two groups. Although the non-affected plants contain about one third of all manufacturing units, the share of those 14,510 observations is only 6.44%, which makes the service sector prevalent for this group.

Using the above mentioned classification, Table 2.3.4 presents descriptive statistics by group and year, respectively. For my analysis, it is necessary to understand which characteristics are similar and which ones are different across the groups and over time. In total, there are about 300,000 observations per year. The non-affected group (also referred to as the control or comparison group) is about four times the size of the affected one, providing a sound basis for potential comparisons. A difference between these groups is a larger share of manufacturers for the affected one: this is as expected, because the BAI primarily liberalized technical barriers to trade. As a measure for firm size, I use employment in full-time equivalent units (FTEs), this being available, compared to output, which is unfortunately not captured. A particularity of the sample is the large share of small plants, distinguishing this study from many others (for example Bernard et al. (2006)). In particular, the 75th percentile of plant size is 5.3

[1] Table 2A.1 in the Appendix provides the complete classification of all industries and further details on the individual decisions.

Table 2.3.2: Classification of Plants by Industry

SIC	Industry	Group Classification		Percentage within	
		Non-Affected	Affected	Group	Total
	Manufacturing				
15	Food and Luxury Food	0	3,126	4.88	1.08
16	Tobacco Products	0	22	0.03	0.01
17	Textiles	0	988	1.54	0.34
18	Apparel	0	1,136	1.77	0.39
19	Leather Products	0	358	0.56	0.12
20	Wood, Cork, etc.	0	6,768	10.56	2.34
21	Paper	0	272	0.42	0.09
22	Publishing, Printing	4,674	0	2.07	1.61
23	Coke, Refined Petroleum	23	0	0.01	0.01
24	Chemicals	0	898	1.40	0.31
25	Synthetics	0	907	1.42	0.31
26	Glass, Ceramic	1,592	0	0.71	0.55
27	Production of Metal	330	0	0.15	0.11
28	Metal Products	7,576	0	3.36	2.62
29	Machinery, Equipment	0	4,028	6.28	1.39
30	Business Machines	0	187	0.29	0.06
31	Electrical Machinery	0	1,322	2.06	0.46
32	Radio, TV, Communications	0	719	1.12	0.25
33	Med. Appar., Precision Instr.	0	3,282	5.12	1.13
34	Automobiles and Parts of Cars	0	233	0.36	0.08
35	Other Vehicles	0	381	0.59	0.13
36	Furniture, Jewelry, etc.	0	4,085	6.37	1.41
37	Recycling	315	0	0.14	0.11
	All Manufacturing Industries	14,510	28,712		14.93
	Services				
40	Energy Supply	408	0	0.18	0.14
41	Water Supply	32	0	0.01	0.01
45	Construction	34,212	0	15.18	11.82
50	Trade Vehicles (also Parts)	0	14,339	22.37	4.95
51	Wholesale and Commission Trade	0	21,039	32.83	7.27
52	Retail Trade	54,058	0	23.99	18.67
55	Lodging and Restaurants	24,042	0	10.67	8.31
60	Land Transportation, Pipelines	7,446	0	3.30	2.57
61	Water Transportation	138	0	0.06	0.05
62	Air Transportation	284	0	0.13	0.10
63	Auxiliary Transport Activities	3,826	0	1.70	1.32
64	Post and Telecommunications	360	0	0.16	0.12
65	Banks, Funds	3,818	0	1.69	1.32
66	Insurance Companies	2,078	0	0.92	0.72
67	Banking Business Activities	1,986	0	0.88	0.69
70	Real Estate and Housing	3,380	0	1.50	1.17
71	Renting of Goods and Chattels	884	0	0.39	0.31
72	Data Processing and Data Bases	5,595	0	2.48	1.93
73	Research and Development	326	0	0.14	0.11
74	Other Business Activity	48,248	0	21.41	16.67
90	Sewage and Waste Treatment	393	0	0.17	0.14
91	Sp. Intr. Groups, Relig. Org.	527	0	0.23	0.18
92	Culture and Sports Activities	4,878	0	2.16	1.69
93	Other Services	13,953	0	6.19	4.82
	All Services Industries	210,872	35,378		85.07
	All Industries	225,382	64,090		100.00

Notes: Shown is the number of plants by industry in the year 1995, classified into 'non-affected' and 'affected' plants, as well as their shares in the respective group and the full sample. The total number of plants is 289,472 with 43,222 units in the manufacturing and 246,250 units in the service sector.

employees and the median is 2.2 employees. Both numbers are calculated by pooling the final sample over all years and groups.[2] The affected plants employ on average 12 workers, which is about twice as many as are employed on average in the control group. The higher share of exporters and importers indicates a better integration into the international markets for the affected group. Moreover, this interpretation is supported by looking at foreign ownership. The non-affected plants hold less foreign assets as well as being less (partly) owned by foreign capital. With respect to all these four characteristics, the affected group exhibits a proportion which is twice as high as for the control group. Regarding the legal form, the sole proprietorship (Sole Prop.) is most prevalent among the non-affected plants. This is consistent, as most of them are small. Over time, the relative importance diminishes for both groups, which results in a reduction of about 12 percentage points from 1995 to 2008. Instead, the limited liability company (LLC) becomes, for both groups, and to the same extent, more important. In particular, the proportions increase from about two percent to more than 16% from 1995 to 2008. The share of stock corporations remains roughly constant for the affected and non-affected companies, at 46% and 34%, respectively. Concerning the kind of municipality, the differences are roughly unchanged between the two groups. About 60% of establishments are located in the center or suburban areas. Non-affected plants prefer the center, affected ones locate roughly equally often in center areas and suburban areas. In the sample, touristic municipalities are observed twice as often in the comparison group. Using a probit model, Table 2A.3 in the Appendix displays a corresponding multivariate analysis of the two groups. Key insights are confirmed. In particular, the probability increases to be among the affected plants if a plant is a manufacturer, importer, or owns foreign capital.

Finally, Table 2.3.3 displays the annualized exit rates for the two groups and the (pooled) sample. The exit rate is 5.8% per annum for the whole sample in the pre-liberalization period ($t = 0$). It increases to 6.5% in the subsequent period. The two post-liberalization periods exhibit decreasing rates over time. Regarding the levels, those periods experience the lowest rates, with 5.6% and 5.3%. These exit rates are similar to those found for the UK and Germany in a study by Cable and Schwalbach (1991). Moreover, with respect to the potential effects of the BAI, it is revealing to look at the outcomes by groups separately. The pre-liberalization period shows a negligible difference in exit rates between the two groups. The anticipation period ($t = 1$) has increasing rates overall but to a greater extent for the control group. Over time, this

[2]The table is available on request from the author.

Table 2.3.3: Annualized Exit Rates by Group and Period

	Period			
	Pre-Liberalization		Post-Liberalization	
Group	$t = 0$	$t = 1$	$t = 2$	$t = 3$
"Non-Affected"	5.9	6.6	5.7	5.4
"Affected"	5.8	6.3	5.1	4.7
Sample	5.8	6.5	5.6	5.3

Note: Shown are the mean exit rates in percent per annum for both groups and the pooled sample in all periods.

difference increases up to 0.7 percentage points, which might indicate a potential effect of the trade liberalization. The comparison of mean exit rates is not sufficient for a credible investigation of the effects of the BAI (including the reduced trade barriers). Other things might have changed over time, as shown in Table 2.3.4 the groups differ in dimensions which influence the exit probability and the possibility of being affected by the trade liberalization, so that this simple mean difference cannot uncover a credible effect. Thus, I use a more sophisticated empirical strategy to obtain more reliable results.

2.4 Econometrics

2.4.1 Estimation Problem and Identification

The purpose of this study is to estimate the effect of liberalizing trade on the (mean) exit rate. The empirical strategy is explained using potential-outcome notation, which is common in the policy evaluation literature (Imbens and Wooldridge, 2009). Here, D is the binary indicator of trade liberalization with realization $d \in \{0, 1\}$. Therefore, the enactment of the BAI is represented by switching D from zero to one. The identification strategy is based on and exploits this specific policy change. The effect is estimated for the binary outcome variable *exit*. Hence, the potential outcome variable is defined as Y_t^d, which describes the potential exit status for a specific value of d in period t.[3] The observable outcome in a specific period t is denoted by Y_t and further observable variables by X_t.

[3]Recall that, as introduced in Section 2.3.2 in Table 2.3.1, that $t \in \{0, 1, 2, 3\}$ defines the four periods (1995/1998), (1998/2001), (2001/2005), and (2005/2008).

Table 2.3.4: Plant Characteristics by Year and Group

	Pre-Liberalization						Post-Liberalization			
	1995		1998		2001		2005		2008	
Variable	"0"	"1"	"0"	"1"	"0"	"1"	"0"	"1"	"0"	"1"
No. Employees	6.6	11.7	6.2	11.1	6.6	11.9	6.6	11.8	6.9	12.6
Manufacturers	6.4	44.8	6.2	41.4	6.0	43.0	5.7	41.2	5.4	40.4
Exporters	11.3	26.8	n/a	n/a	n/a	n/a	12.0	26.9	n/a	n/a
Importers	20.3	44.8	n/a	n/a	n/a	n/a	17.9	45.1	n/a	n/a
Foreign Assets	3.6	4.5	n/a	n/a	2.1	4.8	2.0	4.5	n/a	n/a
Foreign Owned	2.5	5.9	n/a	n/a	2.1	5.3	2.7	6.6	n/a	n/a
Renewal Region	26.9	28.5	26.4	28.5	25.7	28.7	25.5	29.1	25.2	29.5
Legal Form										
Sole Prop.	53.7	44.1	53.2	42.7	49.1	40.1	44.3	35.3	40.9	32.8
Priv.Partner	2.2	0.9	2.3	0.9	2.0	0.7	1.8	0.6	1.8	0.5
Gen. Partner	4.1	3.7	3.7	3.3	3.3	3.0	3.0	2.5	2.5	2.1
LLP	0.7	0.9	0.6	0.7	0.6	0.6	0.5	0.5	0.5	0.4
Stock Corp.	34.1	46.1	31.2	43.7	32.1	43.6	32.7	44.3	33.2	44.2
LLC	1.9	2.5	5.9	6.7	10.2	10.1	14.6	15.1	18.0	18.4
Cooperative	2.5	1.4	2.1	1.4	1.9	1.2	2.1	0.9	2.0	0.7
Foundation	0.5	0.0	0.5	0.0	0.5	0.0	0.6	0.0	0.6	0.0
Foreign Aff.	0.3	0.4	0.5	0.7	0.5	0.8	0.5	0.8	0.5	0.8
Municipality										
Center	40.2	30.0	39.6	28.9	39.7	28.3	39.7	27.7	40.0	27.8
Suburban	24.4	30.6	24.7	31.1	25.4	31.8	25.8	32.5	26.1	32.4
High-Income	3.6	3.6	3.8	3.5	3.9	3.5	3.9	3.4	3.9	3.4
Periurban	7.2	8.7	7.4	9.0	7.5	9.0	7.5	9.2	7.4	9.2
Touristic	5.2	2.6	5.1	2.6	4.9	2.6	4.8	2.6	4.6	2.6
Ind. Tertiary	9.5	10.4	9.5	10.6	9.1	10.6	9.0	10.6	8.7	10.7
Rural	9.8	14.2	10.0	14.3	9.5	14.2	9.4	13.9	9.2	13.9
Region										
Zürich	18.3	18.5	18.2	17.8	18.9	17.3	18.8	17.1	18.9	16.6
Geneva Lake	19.3	16.5	18.6	16.2	18.3	16.5	18.5	16.4	19.2	16.9
Espace ML	21.2	22.2	20.8	22.0	20.3	21.9	20.0	21.4	19.4	21.3
North-West	12.5	12.1	13.1	12.9	13.0	12.9	12.8	12.8	12.8	12.6
East	14.4	15.1	14.9	15.4	14.6	15.5	14.5	15.6	14.1	15.5
Central	9.0	10.3	9.4	10.7	9.8	10.9	10.2	11.2	10.5	11.6
Tessin	5.3	5.2	5.1	5.0	5.1	5.1	5.1	5.4	5.2	5.6
Observations	289,472		301,465		307,589		300,023		308,279	
Proportion	77.9	22.1	78.4	21.6	79.8	20.2	79.8	20.2	80.2	19.8

Notes: Shown are the mean employment (in FTEs) and the percentage shares by year and group. "0" labels the group of non-affected plants, and "1" the affected plants. The definitions and the full names of the variables are provided in Table 2A.4 in the Appendix.

I attempt to answer the question whether the affected plants exhibit, in response to the BAI, a different (mean) exit rate. That is, I am interested in estimating the so-called average-treatment effect on the treated (ATET) in period t,

$$\theta_t = \mathrm{E}(Y_t^1 - Y_t^0 | D_t = 1) \qquad \forall t \in \{1, 2, 3\}. \tag{2.1}$$

It is important to note that for $t = 1$ (the period from 1998 to 2001 and just prior to the enforced liberalization) the estimate for θ_1 measures an anticipation effect, because the relevant referendum was already approved in May 2000. Two post-liberalization periods are available from 2001 to 2005 ($t = 2$) and from 2005 to 2008 ($t = 3$). The corresponding estimates θ_2 and θ_3 are the effects in the short and long term.

It is obvious from Equation (2.1) that without further assumptions, an identification is not possible. The counterfactual, $\mathrm{E}(Y_t^0 | D_t = 1)$, which represents the post-liberalization exit rate for the affected plants if the liberalization had not taken place, is never observed. Accordingly, the strategy is to impose credible assumptions in order to impute this outcome and identify the desired effect.

In order to identify the desired effect from observable quantities, some crucial assumptions need to be imposed (cf. Lechner (2010)). The basic idea of the difference-in-differences approach is to assume that the difference in potential outcomes between the affected and non-affected plants conditional on observable characteristics X_t is time-invariant:

$$\begin{aligned} &\mathrm{E}(Y_t^d | X_t = x_t, D_t = 1) - \mathrm{E}(Y_t^d | X_t = x_t, D_t = 0) \\ &= \mathrm{E}(Y_0^d | X_0 = x_0, D_0 = 1) - \mathrm{E}(Y_0^d | X_0 = x_0, D_0 = 0), \qquad \forall t \in \{1, 2, 3\} \end{aligned} \tag{2.2}$$

which is also known as the constant bias assumption. Hence, if the trade liberalization had not taken place ($d = 0$), a constant bias would have been observed (at least conditional on X) over time. Similarly, if this political decision had affected both groups ($d = 1$), the difference would have remained the same over time. Consequently, any confounding factor (also unobserved) that influences both groups in the same way can be ignored. Rearranging Equation (2.2) shows that this constant bias is equivalent

to

$$\begin{aligned} & \mathrm{E}(Y_t^d|X_t = x_t, D_t = 1) - \mathrm{E}(Y_0^d|X_0 = x_0, D_0 = 1) \\ = \quad & \mathrm{E}(Y_t^d|X_t = x_t, D_t = 0) - \mathrm{E}(Y_0^d|X_0 = x_0, D_0 = 0), \qquad \forall t \in \{1, 2, 3\} \end{aligned} \tag{2.3}$$

the so-called common time trend assumption. Important for this identification strategy is the observability of all factors which jointly influence the outcomes, i.e., exit, and the fact that a plant is affected.[4]

The exogeneity assumption requires the observable characteristics X_t to be unaffected by the trade liberalization. In particular, it is necessary that $X_t^1 = X_t^0 = X_t$ holds for all periods. In a similar way, the pre-liberalization outcome is assumed to be unaffected by the liberalized trade (NEPT), i.e., $\mathrm{E}(Y_0^1 - Y_0^0|X_0 = x_0, D_0 = d) = 0$, $\forall d \in \{0, 1\}$. Hence, any anticipation is ruled out with regard to exit of the affected plants. Let me emphasize that the period $t = 1$ is called the anticipation period because it covers some time after the positive referendum. But it is not the kind of anticipation which is excluded by NEPT.

Moreover, the common support condition means that for every affected plant, there is a matching one in the control group which has the same characteristics. Otherwise, it would be impossible to construct the necessary comparison group.

The last assumption is called the stable unit treatment value assumption (SUTVA, Rubin (1977)). It is necessary to observe one potential outcome for the affected and the non-affected groups. Therefore, this rule of observation does not allow any relevant interaction between the two groups, which means $Y_t = dY_t^1 + (1-d)Y_t^0$ with $d \in \{0, 1\}$.

Finally, the ATET in observables (as shown for example in Lechner (2010)) can be written as

$$\begin{aligned} \theta_t \quad = \quad & \mathrm{E}(Y_t|X_t = x_t, D_t = 1) - \mathrm{E}(Y_0|X_0 = x_0, D_0 = 1) \\ & -[\mathrm{E}(Y_t|X_t = x_t, D_t = 0) - \mathrm{E}(Y_0|X_0 = x_0, D_0 = 0)]. \end{aligned} \tag{2.4}$$

According to Equation (2.3), two important advantages of the proposed difference-in-differences approach are evident, compared to approaches which claim selection is based purely on observables (for example the OLS estimator). First, as already mentioned, there is no need to worry about any confounding factor if it influences both groups in the same way. Second, any unobservable plant-specific confounding factor

[4]This is also called the *conditional independence assumption* (CIA).

which affects all periods in the same way (e.g., individual fixed effects) is no threat to the validity of the approach either.

2.4.2 Plausibility of Assumptions

All the necessary assumptions have been introduced in the previous subsection. In order to provide convincing arguments for the validity of this approach, the plausibility for each of them is now discussed.

First, the SUTVA requires observing one of the potential outcomes for each group at time t. The classification into groups is derived from a careful assessment of the BAI. The impact is translated on that basis into the industry codes.[5] If relevant interaction between the groups took place, the estimates would be biased. For example, suppose the affected industries benefit from liberalizing trade and reduce their exit rates. Then some firms remain in the market which would have otherwise left. This creates additional demand for their suppliers, which are not only within the affected industries. These spillover effects might also decrease the exit rates for the non-affected industries (control group). Such a situation is not desired, because it reduces the change in the difference between the two (post-liberalization) groups. Consequently, the estimates give rather a lower bound for the actual effect. The situation is more problematic if increased (foreign) demand for the affected plants causes the controls to exit the market more frequently. Imagine that an exporter is highly competitive and gains from the liberalization in the affected industries. Furthermore, the exporter is active even across several industries, including the unaffected ones. In these counterfactual industries, the less competitive firms are forced to exit, which leads to upward biased results. As a consequence, a potential bias is in general ambiguous. However, most firms are active in just one industry sector, making the first reasoning more likely, i.e., the effect is rather conservative.

Concerning the two assumptions on the exogeneity of the covariates and the pre-liberalized outcomes (NEPT), the latter is about a firm's decision leaving the market in anticipation of future changes before the year 2000. There is little reason to believe that firms adapt their behavior already before the implementation of the BAI is certain. In Switzerland, in particular, political outcomes remain uncertain until a referendum is approved. What is likely (and does not concern the validity of NEPT) is an adjustment after a successful referendum but before the enactment of the treaties. In that period,

[5] All the details of the classification are available in Table 2A.1 in the Appendix.

firms might either invest and prepare for future opportunities or avoid foreign competition and leave the market. This effect (θ_1) is measured in the anticipation period ($t = 1$). Next, I also assume the exogeneity of the covariates. Based again on the fact that negotiations were still under way, I feel pretty safe that these controls are not influenced and exogenous before May 2000. Concerning the subsequent periods, the question is whether firms adjust their legal form, place of production, employment, and so on, in response to the liberalized trade policy. This is for some characteristics less likely than for others. I am pretty confident that firms do not adjust, or at least, are extremely reluctant to do so, by changing their sector, legal form, place of headquarters, or region, due to the implementation of the BAI. According to Harhoff et al. (1998), for example, the choice of legal form depends primarily on tax treatment, liability, and transfer of ownership. Admittedly, other covariates such as export status or foreign affiliation might be influenced. Therefore, I use in the robustness check a different model specification including only those controls in which I feel most confident.

The common support assumption requires that for every affected plant, there is a comparable observation in the control group. Based on 225,000 available plants in the data and the reasonably large set of control variables, it is feasible to find appropriate comparison plants for the affected ones. As this is testable, I checked it, and my tests suggest no problems.[6]

Finally, the common trend assumption requires controlling for any confounding factor that either constitutes a different time trend or leads to a different distribution of characteristics for the affected and the non-affected group. As described in Section 2.3.3, certain characteristics influence the potential to be among the affected plants,for example, the sector, foreign ownership, or headquarters status. Moreover, there are some characteristics which in particular influence the exit probability of a firm: the legal form, the size, and the export status. The legal form is according to Harhoff et al. (1998) a good predictor for exit potential, which is increased further by a lower liability level. Another determinant is size. Although the exact relationship is not clear in the literature, there is evidence for a decreasing exit probability in size but also for a more U-shaped curve (Buehler et al., 2005). Furthermore, it is reasonable to believe that the geographic location or the kind of municipality also influences the exit probability (Buehler et al., 2010). Suppose management locates some production units closer to the border, so that those plants would benefit to a larger extent from lower transportation

[6] A procedure for propensity score matching was used which was developed by Leuven and Sianesi (2003) to check for the common support.

costs (and not because of the liberalization). Similarly, some municipalities, such as those in the center provide a more export oriented infrastructure (such as airports) than others, for example rural regions. Thus, those factors are included in the estimation procedure to capture their differential effects on outcome and treatment.

2.4.3 Estimation

This subsection treats the ways in which the estimations and robustness checks have been carried out. In this study, I estimate the effect with three specifications: non-parametric, parametric, and semi-parametric. The starting point is the non-parametric specification, which is the unconditional difference-in-differences (cf. Meyer (1995)) assuming no confounders to the common trend and also the same distributions of characteristics for both groups. As argued in the previous subsection and in Section 2.3.3, the two groups differ in some covariates which influence the exit probability and the possibility of being affected by the trade liberalization. Hence, this specification is just a first step to estimate results in a naive way, presented in the Appendix.

A more sophisticated strategy includes such covariates, which is the conditional DiD approach. The parametric specification with θ measuring the effect of liberalization is (Wooldridge, 2008):

$$Y = \alpha_0 + \alpha_1 d + \alpha_2 z + \theta dz + \beta X + \epsilon \qquad \forall d \in \{0, 1\}$$

where Y denotes the binary outcome variable *exit* and $z \in \{0, 1\}$ denotes *time*, with $z = 0$ for the baseline period ($t = 0$) before the liberalization and $z = 1$ for any period (at least partly) affected by this policy change, i.e., $t \in \{1, 2, 3\}$.[7] The error term is denoted by ϵ. Moreover, it includes the characteristics X, which assumes the common trend to hold conditional on these covariates in a linear way. This is a suitable way and leads to unbiased estimates. Nevertheless, I use a third specification which is in this respect more flexible and checks the validity of the results.

This third regression is a semi-parametric specification and allows assessing the robustness of the previous results. In particular, I apply a matching technique so that the covariates can enter in the most flexible way (Lechner, 2010). The idea of this approach relies on the observable characteristics for the affected plants after the implementation of the BAI. I use this group to investigate the impact of the trade liberalization. Based on its particular distribution of characteristics, the comparison (counterfactual)

[7]Hence, there are three separate regressions pooling $t = 0$ separately with $t = 1$, $t = 2$ and $t = 3$.

groups are constructed. Specifically, these are the affected and unaffected plants in the baseline period ($t = 0$) before the liberalization, and the unaffected plants after the implementation. This study observes two post-liberalization periods, i.e., $t \in \{2, 3\}$. In addition, there is the anticipation period ($t = 1$) which might be partly affected by the liberalization. In total, there are three matching estimations employed. Although an exceptionally large data set is available, the inclusion of all relevant characteristics makes it impossible to find a comparable observation for each plant. This is known as the curse of dimensionality, and a solution has been suggested by Rosenbaum and Rubin (1983). They show that if there is a function which maps characteristics into a balancing score such that it provides comparability (of groups), this is already sufficient for matching. They call this function the propensity score:[8]

$$p(X) \equiv \Pr(D = 1|X) = \mathrm{E}(D|X).$$

Their procedure[9] is extremely useful and is applied here as well. In this paper, a probit model is used to estimate the propensity score.[10] A matching procedure is applied which uses an inverse probability weighting to obtain the matched counterfactual outcomes (Huber et al., 2010). The standard errors are calculated based on 500 bootstrap repetitions.

2.5 Results

The objective of this study is to investigate the exit behavior caused by liberalizing trade. The results are summarized in Table 2.5.1, presenting the change in the difference of the (mean) exit rates between the group of affected establishments and unaffected ones. It is this comparison from which I deduce the liberalization effects over time, thereby evaluating the impact of the trade policy. First is shown the parametric specification and then the robustness check below. The figures display the absolute change in levels expressed as percentages. The results are provided in three columns: the first one displays the whole sample and the second and third columns show the two subsamples. The sample is split by size, which is a proxy for productivity, to investigate the heterogenous effects suggested by the new-new trade theory (cf. (Melitz,

[8] It is the probability of belonging to the affected group in a post-liberalization period given the individual characteristics.

[9] Abadie (2005) also proposes reweighting the outcomes on propensity scores.

[10] The estimates are provided for each of the three comparison periods in Table 2A.9 in the Appendix.

2003)). Specifically, there are the lower and the upper halves dividing the sample into plants of a size below and above the median, respectively. The rows show the evolution of the effect over time. In particular, it is the difference between the baseline period $t = 0$ (1995/1998) and one of the three other ones. Those are the anticipation period $t = 1$ (1998/ 2001) and the two post-liberalization periods (2001/2005 and 2005/2008) for short ($t = 2$) and long ($t = 3$) term perspectives.

With regard to the parametric specification, all estimates indicate a negative effect on exit rates which is highly significant for all post-liberalization periods. Hence, the trade policy agreed on in the BAI has a positive impact on the survival of firms. The whole sample suggests an absolute reduction in the exit rate in the short and long term by 1.28 percentage points and 1.54 percentage points, respectively. Already the anticipation period (which covers partly the positive referendum) exhibits a reduction by 0.51 percentage points, which is plausible as it is only one affected year.[11] Hence, the firms benefit immediately from the agreements. Furthermore, the non-parametric specification (which is provided in Table 2A.5 in the Appendix) supports these findings, albeit, as discussed before, the effect is (upward) biased expressed in the larger estimated reductions.

With regard to effect heterogeneity, the sample is split at the median size into small and large plants. In the short term, the large establishments reduce their average exit rate by 0.99 percentage points compared to 1.48 percentage points for the small ones. In the long term, the two subsamples exhibit only marginal differences, with a reduction in percentage points of 1.41 and 1.66, respectively. The findings suggest an anticipation effect only for the lower half of the sample. Hence, the adjustment time, which is the period of transition until plants have adjusted completely to the new level of exit rates, is shorter for smaller than for larger plants. In particular, the small plants exhibit already in the short term perspective reduced (new) exit rates. The large plants adjust considerably more slowly, which results in no effect for the anticipation period and increasing reduction levels until the long term period $t = 3$.

Regarding the new-new trade theory, a reduction in the exit rate which is independent of size (as a proxy for productivity) is not in line with their predictions. Instead, it is the closure of the least productive (small) firms which is an implication also found in recent studies (Pavcnik, 2002; Bernard et al., 2006). According to the theory and based on this evidence, there is a new (post-liberalization) productivity distribution where the

[11] The anticipation period ($t = 1$) covers the years 1998 until 2001. Therefore, a referendum in the year 2000 affects about one third of this three years period.

Table 2.5.1: Estimation Results of the ATET

		Parametric Specification		
		Sample	Subsample	
Period	Effect (θ_t)	Complete	Lower Half	Upper Half
$t = 1$	Anticipation (θ_1)	-0.51**	-0.72*	-0.16
		(0.25)	(0.39)	(0.29)
$t = 2$	Short Term (θ_2)	-1.28***	-1.48***	-0.99***
		(0.24)	(0.39)	(0.28)
$t = 3$	Long Term (θ_3)	-1.54***	-1.41***	-1.66***
		(0.24)	(0.39)	(0.27)
		Semi-Parametric Specification (Robustness)		
		Sample	Subsample	
Period	Effect (θ_t)	Complete	Lower Half	Upper Half
$t = 1$	Anticipation (θ_1)	0.88***	0.15	1.02***
		(0.22)	(0.84)	(0.32)
$t = 2$	Short Term (θ_2)	-0.97***	-1.27***	-0.99***
		(0.23)	(0.52)	(0.27)
$t = 3$	Long Term (θ_3)	-2.26***	-1.98***	-2.54***
		(0.25)	(0.54)	(0.41)

Notes: The change in the (mean) exit rate is shown, presented in percentage points for the whole sample and the two subsamples. Accordingly, the lower and upper halves indicate the below and above median employment observations. The complete regressions for the parametric specification are provided in Tables 2A.6, 2A.7, and 2A.8 in the Appendix. The effect (θ_t) is estimated as the difference at the mean between one of the three comparison periods (i.e.,$t = 1$, $t = 2$, or $t = 3$) and the pre-liberalization period ($t = 0$). Recall that all periods are defined in Section 2.3.2 in Table 2.3.1. For the post-liberalization period with short term horizon ($t = 2$), it is assumed that exit is uniformly distributed over time. Thereby, it is possible to adjust the observable 'four years period' (from year 2001 until year 2005) to a shorter 'three years one,' which makes the results comparable to the ones of the other periods. The complete sample includes 590,937, 597,061, and 589,495 observations before and after treatment (stayers counted twice, entrants and exitors only once) for θ_1, θ_2, and θ_3, respectively. Similarly, the sample restricted to below (above) median size plants consists of 301,996 (288,941), 304,226 (292,835), and 300,757 (288,738) observations.
The semi-parametric specification checks for the robustness of these results. As described in Section 2.4.3, I use an inverse probability estimator. The probit estimates for the propensity score are provided in Table 2A.9. The standard errors are in parentheses and were obtained by a bootstrap procedure at the plant level based on 500 replications.
For both specifications, the symbols *, **, and *** indicate that the estimates are significant at the 10%, 5%, and 1% level, respectively.

more productive establishments survive. Based on this evidence, using an exogenous constant exit rate is a rather strict assumption (Melitz, 2003). If only the more productive plants survive, one could imagine a change in the exit rate as well. This study provides evidence that the exit rate is affected by the trade liberalization. Another argument for this relationship is made by Brander (1995) and Zingales (1998). They argue that higher profits allow a reduction in debts and increase survival probability from exogenous shocks. Those additional earnings come from the larger market share for the most productive firms (Melitz, 2003), the creation of additional trade (Trefler, 2004; Bustos, 2011), and better access to foreign markets (Baggs, 2005). A third explanation is based on different, rather than common, productivity distributions across countries: this can change the predictions in the model proposed by Melitz. Suppose one of the countries has already before the liberalization a superior productivity distribution. In particular, this is one where the least productive firm is already endowed with the necessary productivity to survive in the free trade environment. This country would only benefit from the increased profits through the aforementioned channels allowing for a reduction of debts, and this results in a lower exit probability.

The check on the robustness of the results is provided in Table 2.5.1 as well. It is the semi-parametric specification which allows the covariates to enter in the most flexible way. The previous findings for the post-liberalization estimates (θ_2 and θ_3) are confirmed. In particular, the reduction of the (mean) exit rate is between 0.97 percentage points and 2.54 percentage points for the whole sample and the two subsamples. Moreover, all the estimates are significant and the signs are of the expected direction. The magnitude is higher, which suggests an even stronger impact of the agreements. Nevertheless, the order of magnitude is preserved, supporting the parametric outcomes. Only the estimates for the anticipation period (θ_1) are not robust to the estimation procedure. For the subsample of small plants, the effect becomes insignificant, and for the other two samples, the sign is reversed. Potential reasons might be the relatively short time for adjustment (one year) and the imprecise measurement within a three year period.

These findings suggest robust evidence for a short and long term effect that reduces the exit rate by 1.5 percentage points per period. This is attributed to the liberalized trade policy, achieved through the BAI. The affected establishments have benefited from better export opportunities, leading to increased survival chances after 2001. This effect is observed independently of firm size, it is not just the large (more productive) plants which gain from trade liberalization.

2.6 Conclusion

This paper investigates the effect of liberalized trade on exit. Based on comprehensive plant-level data from Switzerland covering the years from 1995 to 2008, I analyze the implementation of the Bilateral Agreements I (BAI) in the year 2002. A pillar of this bundle of agreements is reducing the trade barriers between Switzerland and the European Communities. In this analysis the treaties serve as a plausible exogenous variation and allow employing a conditional difference-in-differences approach to isolate its effect.

The findings show a significant negative effect on the exit rate for all post-liberalization periods. The whole sample suggests an absolute reduction in the exit rate in the short and long term by roughly 1.3 percentage points and 1.5 percentage points, respectively. Furthermore, there is evidence for an anticipation effect between the positive result of the referendum and the enactment of the agreements, implying that firms already reacted before the implementation into national law. Concerning effect heterogeneity, the subsample of small establishments adjust more rapidly than the larger ones to the new (lower) level of exit rates. A potential explanation is that smaller firms are more flexible and benefit more rapidly from additional demand opportunities.

These findings are not consistent with the predictions of the new-new trade theory, which expects the exit of the least productive firms and the exit rate is assumed to be constant (Melitz, 2003). However, if only the most productive remained, one could imagine a change in the exit rate. This study provides evidence for such a relationship between trade liberalization and the exit rate, which might indicate that further research on endogenizing is needed. A potential channel is the increased profits for the remaining high productive firms. This allows them to reduce their debts, which in turn increases survival probabilities in response to exogenous shocks. A similar argument derives from relaxing the assumption of a common underlying productivity distributions across liberalizing countries, which does not apply in this analysis. If instead this assumption is relaxed to allow for a superior distribution in one country, which means its least productive firm survives also in the post-liberalization environment, the predictions would be different. In particular, there would be no exit (of the least productive firms) for the more advanced country. Instead, this country only benefits from better market access. Based on the fact that the BAI target (mostly) technical industries and Switzerland is specialized and advanced in those technical industries, this potentially makes my study an example for such a case.

Finally, this study adds to the literature on determinants explaining entry and exit. I find that liberalized trade is an important factor which explains a (permanent) shift in the exit rate.

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2A Appendix to Chapter 2

Table 2A.1: Industry Classification into Groups

	Agreement							Group	Comment(s)
	A	B	C	D	E	F	G		
Mining of Coal and Minerals, Extraction of Oil and Peat									
10 Mining of Coal and Extraction of Peat	0	1	0	0	0	0	0	9	B1
11 Extraction of Crude Oil and Gas	0	1	0	0	0	0	0	9	B1
12 Mining of Uranium and Thorium Ores	0	1	0	0	0	0	0	9	B1
Mining of Iron Ores and Quarrying									
13 Mining of Iron Ores	0	1	0	0	0	0	0	9	B1
14 Other Mining and Quarrying	0	1	0	0	0	0	0	9	B1
Manufacturing of Food									
15 Food and Beverage	1	1	1	0	0	0	0	1	A2, B1,C1,C2
16 Tobacco Products	1	1	1	0	0	0	0	1	A2, B1,C1,C2
Manufacturing of Textiles and Textile Products									
17 Textiles	1	1	0	0	0	0	0	1	A1,A2,B1,X17
18 Apparel	1	1	0	0	0	0	0	1	A1,A2,B1
Leather and Leather Products									
19 Leather Products	1	1	0	0	0	0	0	1	A1,A2,B1
Manufacturing of Wood and Wood Products									
20 Wood, Cork, ...	1	1	0	0	0	0	0	1	A1,A2,B1
Manufacturing of Pulp, Paper and Paper Products									
21 Paper	1	1	0	0	0	0	0	1	A2,B1
22 Publishing, Printing	0	1	0	0	0	0	0	0	A2,B1
Manufacturing of Koke and Refined Petroleum									
23 Koke, Refined Petroleum	0	1	0	0	0	0	0	0	B1
Manufacturing of Chemicals and Chemical Products									
24 Chemicals	1	1	1	0	0	0	0	1	A1,B1,C2
Manufacturing of Syntheticals and Synthetical Products									
25 Syntheticals	1	1	0	0	0	0	0	1	A1,B1
Manufacture of Non-Metalic Mineral Products									
26 Glass, Ceramic, etc.	1	1	0	1	0	0	0	0	A2,B1,X26
Production, Manufacturing of Metal and Metal Products									
27 Production of Metal	0	1	0	1	0	0	0	0	B1,X26
28 Metal Products	0	1	0	1	0	0	0	0	B1,X26
Manufacturing Systems Engeneering									
29 Machinery, Equipment	1	1	0	1	0	0	0	1	A1,A2,B1,D1
Manufacturing of Business Machines									
30 Business Machines	1	1	0	1	0	0	0	1	A1,A2,B1,D1
31 Electric Machinery	1	1	0	1	0	0	0	1	A1,A2,B1,D1
32 Radio, TV, Communication Apparatus	1	1	0	0	0	0	0	1	A1,A2,B1
33 Med. Apparatus, Precision Instruments	1	1	0	1	0	0	0	1	A1,A2,B1
Vehicle Manufacturing									
34 Automobiles and Parts of Cars	1	1	0	1	0	0	0	1	A1,B1,D1
35 Other Vehicles	1	1	0	1	0	0	0	1	A1,B1,D1

Table 2A.1: Industry Classification into Groups (continued)

		Agreement							Group	Comment(s)
		A	B	C	D	E	F	G		
Manufacturing of Furniture, Jewellery, Musical Instruments										
36	Furniture, Jewellery, etc.	1	1	0	0	0	0	0	1	A1,B1
37	Recyling	0	1	0	0	0	0	0	0	B1
Electricity, Gas and Water Supply										
40	Energy Supply	0	1	0	1	0	0	0	0	B1,D2
41	Water Supply	0	1	0	1	0	0	0	0	B1,D2
Construction Industry										
45	Construction	0	1	0	1	0	0	0	0	B1,D2
Retail and Wholesale Trade, Repair of Automobiles										
50	Trade of parts and complete Vehicles Repair and Maintenance	1	1	0	0	0	0	0	1	A1,B1
51	Wholesale and Commission Trade	1	1	0	0	0	0	0	1	B1,X51
52	Retail Trade	0	1	1	0	0	0	0	0	B1,C1,X52
Lodging and Restaurants										
55	Lodging and Restaurants	0	1	0	0	0	0	0	0	B1
Transportation and Communication										
60	Land Transportation and Pipelines	0	1	0	0	1	0	0	0	B1,E1
61	Water Transportation	0	1	0	0	0	0	0	0	B1
62	Air Transportation	0	1	0	0	0	1	0	0	B1,F1
63	Auxiliary Transport Activities	0	1	0	0	1	1	0	0	B1,E1,F1
64	Post and Telecommunications	0	1	0	0	0	0	0	0	B1
Credit Institutions and Insurances										
65	Commercial and Central Banks, Fonds	0	1	0	0	0	0	0	0	B1
66	Insurance Companies	0	1	0	0	0	0	0	0	B1
67	Banking Business Activities	0	1	0	0	0	0	0	0	B1
Real Estate and Housing, Renting of Good and Chattels										
70	Real Estate and Housing	0	1	0	0	0	0	0	0	B1
71	Renting of Goods and Chattels	0	1	0	0	0	0	0	0	B1
72	Data Processing and Data Bases	0	1	0	1	0	0	0	0	B1,D1
73	Research and Development	0	1	0	0	0	0	1	0	B1,G
74	Other Business Activity	0	1	0	0	0	0	0	0	B1
Public Administration, Social Insurance										
75	Public Administration, Social Insurance	0	0	0	0	0	0	0	9	
Education										
80	Education	0	0	0	0	0	0	0	9	
Health Care, Welfare										
85	Health Care, Welfare	0	0	0	0	0	0	0	9	
Other Public or Private Services										
90	Sewage and Waste Treatment	0	1	0	1	0	0	0	0	B1,D1
91	Lobby, Religious Organizations	0	1	0	0	0	0	0	0	B1
92	Culture and Sports Activities	0	1	0	0	0	0	0	0	B1
93	Other Services	0	1	0	0	0	0	0	0	B1
Private Households Goods and Services										
95	Households with Employees	0	1	0	0	0	0	0	0	B1
96	Manufacturing for own use	0	1	0	0	0	0	0	0	B1
97	Services for own use	0	1	0	0	0	0	0	0	B1

Notes: "0", "1" and "9" label the groups of non-affected, affected, and excluded plants, respectively. You can find the "comments" below this table.

Comments:

(A1) The MRA explicitly covers the following industries: (1) Machinery; (2) Personal protective equipment; (3) Toys; (4) Medical devices; (5) Gas appliances and boilers; (6) Pressure vessels; (7) Telecommunications terminal equipment; (8) Equipment and protective systems intended for use in potentially explosive atmospheres; (9) Electrical equipment and electromagnetic compatibility; (10) Construction plants and equipment; (11) Measuring instruments and prepackages; (12) Motor vehicles; (13) Agricultural and forestry tractors; (14) Good laboratory practice (GLP); (15) Medical products GMP Inspection and Batch Certification.

(A2) The MRA does not cover all "packing" from either country. Since the MRA allows to ask for conformity in a single inspection authority, it substantially eases the proof of conformity.

(B1) The *agreement on the free movement of persons* ensures equal treatment of Swiss and EU citizens in taking up residence and work. However, the inflow of workers from EU-15 countries continued to be limited by quotas until May 31, 2007, and it is still limited for other EU countries. It is thus reasonable to assume that, at least until summer 2007, this agreement had virtually no impact on Swiss industries.

(C1) The *agreement on agricultural products* liberalizes the cheese market (free trade since June 2007) and simplifies trade in other agricultural products. The treaty should be expected to influence all industries dealing with agricultural products.

(C2) The *agreement on agricultural products* removes technical trade barriers in the following fields: (1) Crop protection; (2) Animal feed; (3) Viniculture; (4) Spirits and flavored drinks containing wine; (5) Organic products and foodstuff; (6) Recognition of conformity checks for fruit and vegetables subject to marketing standards; (7) Veterinary and breeding measures applicable to trade in living animals and animal products.

(D1) The first chapter of the *agreement on public procurement* extends the WTO rules and subjects public authorities and bodies at the district and municipality level to compulsory tendering.

(D2) The second chapter of the *agreement on public procurement* subjects licensed firms (e.g. , telecommunications and railway operators) to compulsory tendering.

(E1) The *agreement on ground transportation* increases the maximum weight limit for heavy trucks from 28 to 40 tonnes and prescribes the introduction of a Pigouvian tax on heavy vehicles, which provides incentives for moving transalpine freight from road to rail.

(F1) The *agreement on civil aviation* stipulates reciprocal access to aviation markets (including landing rights).

(G) The *agreement on scientific and technological cooperation* regulates the participation of Swiss research institutions and individual in EU programs.

(X17) Not affected by agreement D (no evidence for tendering).

(X26) Affected by agreement D (public tendering is observed).

(X51) Affected by agreement A (cf. A1 and A2 above).

(X52) Affected by agreement C, because agricultural products are imported more easily (cf. C1 above).

Table 2A.2: Sample Size

	Year				
	1995	1998	2001	2005	2008
Complete Data Base	372,782	379,330	385,074	375,167	389,165
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Eliminated Plants					
Non-Private	37,892	35,361	34,073	33,050	32,747
	(10.16)	(9.32)	(8.85)	(8.81)	(8.41)
Mining Industries etc.	34,672	34,560	36,283	35,462	37,156
	(9.30)	(9.11)	(9.42)	(9.45)	(9.55)
Coding Mistakes	10,746	7,944	7,129	6,632	10,983
	(2.88)	(2.09)	(1.85)	(1.77)	(2.82)
(Final) Sample	289,472	301,465	307,589	300,023	308,279
	(77.65)	(79.47)	(79.88)	(79.97)	(79.22)

Notes: Shown is the number and share of plants by year. "Coding Mistakes" refers to any plant that disappeared for one or more periods and then reappeared with the same plant identification number (PID). According to the sampling rules of the Federal Statistical Office the PID is unique. Therefore, I have to consider this as a mistake and clean the data to avoid any bias. In doing so, I proceed in the exact same manner as Disney et al. (2003, 94).

Table 2A.3: Binary Probit Estimates

	Period t		
Variable	$t = 1$	$t = 2$	$t = 3$
Headquarter	0.1006***	0.0952***	0.0930***
Service Industries	-0.4521***	-0.4572***	-0.4583***
Exporter	0.0265***	0.0228***	0.0223***
Exporter-missing	0.0192***	0.0178***	0.0190***
Importer	0.1750***	0.1677***	0.1684***
Importer-missing	-0.0076**	-0.0123***	-0.0111***
Foreign Ownership/Assets (Reference: "Not Owned" and "Not Owner")			
Owns	-0.0227***	-0.0222***	-0.0222***
Owns-missing	0.0105***	0.0002	0.0026
Owned	0.1030***	0.0999***	0.1018***
Owned-missing	0.0086***	0.0104***	0.0113***
Legal Form (Reference: "Sole Proprietorship")			
Private Partnership	-0.0651***	-0.0644***	-0.0688***
General Partnership	0.0152***	0.0164***	0.0130***
Limited Liability Partnership (LLP)	0.0356***	0.0257***	0.0249***
Stock Corporation	0.0591***	0.0553***	0.0569***
Limited Liability Company (LLC)	0.0555***	0.0392***	0.0455***
Cooperative	0.0213***	0.0156***	-0.0028
Foundation	-0.1480***	-0.1468***	-0.1528***
Foreign Affiliate belongs to LLC	0.0919***	0.0975***	0.0992***
Foreign Aff. belongs to Stock Corp.	0.1513***	0.1540***	0.1590***
Municipality (Reference: Center)			
Suburban	0.0653***	0.0644***	0.0663***
High-Income	0.0408***	0.0394***	0.0385***
Periurban	0.0668***	0.0639***	0.0661***
Touristic	-0.0170***	-0.0158***	-0.0161***
Industrial Tertiary	0.0422***	0.0416***	0.0418***
Rural Commuter	0.0874***	0.0862***	0.0863***
Renewal Economic Region	0.0116***	0.0117***	0.0139***
Region (Reference: Zürich)			
Geneva Lake	-0.0005	0.0040***	0.0012
Espace Midland	-0.0073***	-0.0045***	-0.0066***
North-West	-0.0156***	-0.0111***	-0.0108***
East	-0.0024	0.0022	0.0021
Central	0.0082***	0.0093***	0.0089***
Tessin	0.0044*	0.0103***	0.0112***
Size (Non-linear)	YES	YES	YES
Observations:	590.937	597.061	589.495

Notes: The binary dependent variable is to be in a "not affected"(0) or an "affected"(1) industry. Coefficients show the average marginal effects and for the dummy variables discrete changes in the quantities of interest. The symbols *, **, and *** indicate that estimates are significant at the 10%, 5%, and 1% level, respectively. The respective periods are pooled with observations from Period "0". The definitions of the variables are presented in Table 2A.4 in the Appendix.

Table 2A.4: Definitions of the Variables

Variable	Description
Headquarter	Plant is a headquarter of a Multi-Plant Company.
Service Industries	Plant is in the service and not the manufacturing sector.
Exporter	Plant belongs to a firm which exports to foreign markets.
Non-Exporter (omitted)	Plant belongs to a firm which does not export to foreign markets.
Exporter-missing	Survey question is not asked (1998, 2001 and 2008) or not answered.
Importer	Plant belongs to a firm which imports from abroad.
Non-Importers (omitted)	Plant belongs to a firm which does not import from abroad.
Importer-missing	Survey question is not asked (1998, 2001 and 2008) or not answered.
Renewal Economic Region	Region is eligible for public funds supporting regional development.
Size	Plant's employment is measured in FTEs.
Foreign Ownership/Assets	
Owns	Plant belongs to a firm which (partly) owns foreign assets.
Owns-missing	Survey question is not asked (1998 and 2008) or not answered.
Owned	Plant belongs to a firm which is (partly) owned by foreign capital.
Owned-missing	Survey question is not asked (1998 and 2008) or not answered.
Municipality	
Center	Central municipality of a large agglomeration in a metropolitan region.
Suburban	Suburban or job-rich (non-central) municipality in a metropolitan region.
High-Income	Real income per resident exceeds some specific threshold in the region.
Periurban	Municipality in an agglomeration (neither suburban nor high-income).
Touristic	Municipality featuring a high number of touristic overnight stays.
Industrial Tertiary	Municipality with a high production of industrial goods and services.
Rural Commuter	Municipality located outside an agglom. with a high share of commuters.
Rural Mixed	Municipality with a relatively high share of agrarian production.
Rural Municipality	Municipality with high share of agrarian production.
Company's Legal Form	*Legal Term in the Swiss Law (German)*
Sole Proprietorship	Einzelperson
Private Partnership	Einfache Gesellschaft (Equivalent to "GbR" in Germany)
General Partnership	Kollektivgesellschaft (Equivalent to "OHG" in Germany)
Limited Liability Partnership (LLP)	Kommanditgesellschaft (KG)
Stock Corporation	Aktiengesellschaft (AG)
Limited Liability Company (LLC)	Gesellschaft mit beschränkter Haftung (GmbH)
(Registered) Cooperative	(eingetragene) Genossenschaft (e.G.)
Foundation	Stiftung
Foreign Affiliate of LLC	Zweigniederlassung einer ausländischen AG
Foreign Aff. (Stock Corp.)	Zweigniederlassung einer ausländischen GmbH
Geographic Region	*Canton*
Zürich	Zürich
Geneva Lake	Geneva, Vaud, Valais
Espace Midland	Bern, Fribourg, Jura, Neuchâtel, Solothurn
North-West	Aargau, Basel-Country, Basel-City
East	Appenzell Inner-Rhodes, Appenzell Outer-Rhodes, Glarus, Graubünden, St. Gallen, Schaffhausen, Thurgau
Central	Lucerne, Nidwalden, Obwalden, Schwyz, Uri, Zug
Tessin	Ticino

Notes: Municipalities and geographic regions are classified by the Swiss Federal Statistical Office and documented in Schuler et al. (2005).

Table 2A.5: Unconditional Difference-in-Differences Estimates

	Complete Sample		
	$t = 1$	$t = 2$	$t = 3$
Time (Dummy)	0.0236***	0.0008	-0.0146***
	(0.0012)	(0.0011)	(0.0011)
Affected (Dummy)	-0.0035**	-0.0035**	-0.0035**
	(0.0018)	(0.0017)	(0.0017)
DiD-Effect (='Time'x'Affected')	-0.0066***	-0.0184***	-0.0212***
	(0.0025)	(0.0025)	(0.0024)
Constant	0.1867***	0.1867***	0.1867***
	(0.0008)	(0.0008)	(0.0008)
Observations:	590.937	597.061	589.495
	Subsample Below Median		
	$t = 1$	$t = 2$	$t = 3$
Time (Dummy)	0.0289***	0.0061***	-0.0099***
	(0.0018)	(0.0017)	(0.0017)
Affected (Dummy)	0.0032	0.0032	0.0032
	(0.0029)	(0.0028)	(0.0028)
DiD-Effect (='Time'x'Affected')	-0.0073*	-0.0164***	-0.0147***
	(0.0040)	(0.0040)	(0.0040)
Constant	0.2451***	0.2451***	0.2451***
	(0.0013)	(0.0013)	(0.0013)
Observations:	301.996	304.226	300.757
	Subsample Above Median		
	$t = 1$	$t = 2$	$t = 3$
Time (Dummy)	0.0112***	-0.0113***	-0.0263***
	(0.0014)	(0.0014)	(0.0013)
Affected (Dummy)	0.0016	0.0016	0.0016
	(0.0021)	(0.0020)	(0.0019)
DiD-Effect (='Time'x'Affected')	-0.0025	-0.0138***	-0.0205***
	(0.0030)	(0.0028)	(0.0028)
Constant	0.1259***	0.1259***	0.1259***
	(0.0010)	(0.0010)	(0.0009)
Observations:	288.941	292.835	288.738

Notes: The binary dependent variable is "1" for 'exit' and "0" for 'not-exit' during the defined periods. The symbols *, **, and *** indicate that estimates are significant at the 10%, 5%, and 1% level, respectively. The standard errors are in parentheses. The respective periods ($t \in \{1, 2, 3\}$) are pooled with observations from Period 0.

Table 2A.6: Parametric Difference-in-Differences Estimates (Complete Sample)

Variable	$t = 1$	$t = 2$	$t = 3$
Time (Dummy)	0.0044***	-0.0245***	-0.0443***
Affected (Dummy)	0.0115***	0.0083***	0.0107***
DiD-Effect (='Time'x'Affected')	-0.0051**	-0.0128***	-0.0154***
Headquarter	-0.0644***	-0.0628***	-0.0619***
Service Industries	0.0061***	0.0040**	0.0094***
Exporter	0.0083***	0.0114***	0.0095***
Exporter-missing	0.0279***	0.0139***	0.0212***
Importer	-0.0047***	-0.0036**	-0.0021
Importer-missing	0.0042	0.0108***	0.0031
Foreign Ownership/Assets (Reference: "Not Owned" and "Not Owner")			
Owns	0.0232***	0.0338***	0.0244***
Owns-missing	0.0457***	0.0361***	0.0344***
Owned	0.0187***	0.0182***	0.0116***
Owned-missing	-0.0031	-0.0049	-0.0074**
Legal Form (Reference: "Sole Proprietorship")			
Private Partnership	0.0265***	0.0089**	0.0133***
General Partnership	0.0473***	0.0305***	0.0275***
LLP	0.0386***	0.0331***	0.0267***
Stock Corporation	0.0274***	0.0437***	0.0377***
LLC	0.0263***	0.0424***	0.0325***
Cooperative	-0.0165***	-0.0055	-0.0196***
Foundation	-0.0351***	-0.0230***	-0.0101
For.Aff.(LLC)	0.1674***	0.1668***	0.1463***
For.Aff.(Stock Corp.)	0.2179***	0.1990***	0.1847***
Municipality (Reference: Center)			
Suburban	-0.0027**	-0.0023*	-0.0001
High-Income	-0.0024	0.0034	0.0043
Periurban	-0.0134***	-0.0115***	-0.0089***
Touristic	-0.0265***	-0.0208***	-0.0192***
Industrial Tertiary	-0.0148***	-0.0192***	-0.0163***
Rural Commuter	-0.0158***	-0.0201***	-0.0153***
Renewal Economic Region	-0.0021	-0.0014	-0.0042***
Region (Reference: Zürich)			
Geneva Lake	0.0154***	0.0103***	0.0124***
Espace Midland	0.0045**	-0.0013	0.0014
North-West	0.0042**	-0.0007	-0.0017
East	0.0020	-0.0042**	0.0016
Central	-0.0000	-0.0023	0.0009
Tessin	0.0176***	0.0021	0.0091***
Size (Non-linear)	YES	YES	YES
Observations:	590.937	597.061	589.495

Notes: The binary dependent variable is "1" for 'exit' and "0" for 'not-exit' during the defined periods. The symbols *, **, and *** indicate that estimates are significant at the 10%, 5%, and 1% level, respectively. The respective periods ($t \in \{1, 2, 3\}$) are pooled with observations from Period 0. The definitions of the variables are presented in Table 2A.4.

Table 2A.7: Parametric Difference-in-Differences Estimates (Below Median)

Variable	$t = 1$	$t = 2$	$t = 3$
Time (Dummy)	0.0058***	-0.0220***	-0.0439***
Affected (Dummy)	0.0167***	0.0128***	0.0163***
DiD-Effect (='Time'x'Affected')	-0.0072*	-0.0148***	-0.0141***
Headquarter	-0.0747***	-0.0706***	-0.0739***
Service Industries	0.0243***	0.0185***	0.0265***
Exporter	-0.0007	0.0041	0.0034
Exporter-missing	0.0297***	0.0103*	0.0235***
Importer	0.0006	-0.0012	0.0003
Importer-missing	0.0074	0.0148***	0.0031
Foreign Ownership/Assets (Reference: "Not Owned" and "Not Owner")			
Owns	0.0532***	0.0635***	0.0531***
Owns-missing	0.0472***	0.0412***	0.0407***
Owned	0.0223***	0.0289***	0.0095
Owned-missing	-0.0039	-0.0115**	-0.0139**
Legal Form (Reference: "Sole Proprietorship")			
Private Partnership	0.0443***	0.0187***	0.0231***
General Partnership	0.0785***	0.0613***	0.0588***
LLP	0.0389***	0.0352***	0.0332***
Stock Corporation	0.0387***	0.0577***	0.0503***
LLC	0.0164***	0.0415***	0.0261***
Cooperative	0.0365***	0.0295***	0.0202***
Foundation	-0.0464***	-0.0480***	-0.0350**
For.Aff.(LLC)	0.2099***	0.2173***	0.1916***
For.Aff.(Stock Corp.)	0.2209***	0.2189***	0.1980***
Municipality (Reference: Center)			
Suburban	-0.0019	-0.0019	-0.0011
High-Income	-0.0045	0.0024	0.0006
Periurban	-0.0158***	-0.0136***	-0.0120***
Touristic	-0.0271***	-0.0207***	-0.0188***
Industrial Tertiary	-0.0137***	-0.0217***	-0.0190***
Rural Commuter	-0.0182***	-0.0240***	-0.0192***
Renewal Economic Region	-0.0018	0.0009	-0.0031
Region (Reference: Zürich)			
Geneva Lake	0.0173***	0.0124***	0.0152***
Espace Midland	0.0064**	0.0003	0.0027
North-West	0.0052*	0.0000	-0.0019
East	0.0002	-0.0057**	0.0039
Central	0.0000	0.0022	0.0052*
Tessin	0.0260***	0.0012	0.0100**
Size (Non-linear)	YES	YES	YES
Observations:	301.996	304.226	300.757

Notes: The binary dependent variable is "1" for 'exit' and "0" for 'not-exit' during the defined periods. The symbols *, **, and *** indicate that estimates are significant at the 10%, 5%, and 1% level, respectively. The respective periods ($t \in \{1, 2, 3\}$) are pooled with observations from Period 0. The definitions of the variables are presented in Table 2A.4.

Table 2A.8: Parametric Difference-in-Differences Estimates (Above Median)

Variable	$t = 1$	$t = 2$	$t = 3$
Time (Dummy)	0.0024	-0.0274***	-0.0470***
Affected (Dummy)	0.0086***	0.0055**	0.0070***
DiD-Effect (='Time'x'Affected')	-0.0016	-0.0099***	-0.0166***
Headquarter	-0.0637***	-0.0637***	-0.0610***
Service Industries	-0.0060***	-0.0059***	-0.0024
Exporter	0.0092***	0.0107***	0.0078***
Exporter-missing	0.0237***	0.0180***	0.0191***
Importer	-0.0084***	-0.0040**	-0.0034*
Importer-missing	0.0002	0.0058	0.0028
Foreign Ownership/Assets (Reference: "Not Owned" and "Not Owner")			
Owns	0.0111***	0.0216***	0.0129***
Owns-missing	0.0390***	0.0285***	0.0271***
Owned	0.0147***	0.0122***	0.0095***
Owned-missing	-0.0029	0.0009	-0.0023
Legal Form (Reference: "Sole Proprietorship")			
Private Partnership	0.0120***	0.0039	0.0072
General Partnership	0.0248***	0.0092***	0.0055*
LLP	0.0284***	0.0211***	0.0120*
Stock Corporation	0.0079***	0.0234***	0.0200***
LLC	0.0457***	0.0452***	0.0437***
Cooperative	-0.0521***	-0.0350***	-0.0473***
Foundation	-0.0438***	-0.0233***	-0.0082
For.Aff.(LLC)	0.1289***	0.1200***	0.1073***
For.Aff.(Stock Corp.)	0.2026***	0.1650***	0.1673***
Municipality (Reference: Center)			
Suburban	-0.0047***	-0.0039**	-0.0002
High-Income	-0.0033	0.0004	0.0058
Periurban	-0.0127***	-0.0105***	-0.0069***
Touristic	-0.0302***	-0.0241***	-0.0225***
Industrial Tertiary	-0.0183***	-0.0181***	-0.0151***
Rural Commuter	-0.0153***	-0.0164***	-0.0117***
Renewal Economic Region	-0.0025	-0.0033**	-0.0048***
Region (Reference: Zürich)			
Geneva Lake	0.0129***	0.0084***	0.0099***
Espace Midland	0.0012	-0.0037*	-0.0005
North-West	0.0018	-0.0024	-0.0022
East	0.0031	-0.0036	-0.0013
Central	-0.0021	-0.0093***	-0.0054**
Tessin	0.0099***	0.0043	0.0100***
Size (Non-linear)	YES	YES	YES
Observations:	288.941	292.835	288.738

Notes: The binary dependent variable is "1" for 'exit' and "0" for 'not-exit' during the defined periods. The symbols *, **, and *** indicate that estimates are significant at the 10%, 5%, and 1% level, respectively. The respective periods ($t \in \{1, 2, 3\}$) are pooled with observations from Period 0. The definitions of the variables are presented in Table 2A.4.

Table 2A.9: Probit Estimates for the Propensity Score

	Period 1					
	Coefficients			Average Marginal Effects		
Variable	(1)	(2)	(3)	(1)	(2)	(3)
Headquarter	0.2130***	0.1699***	0.3636***	0.0483***	0.0669***	0.0804***
Service Industries	-1.3688***	0.0753***	-1.3535***	-0.4628***	0.0298***	-0.4544***
Legal Form (Reference: "Sole Proprietorship")						
Private Partnership	-0.3481***	0.0087	-0.3153***	-0.0737***	0.0034	-0.0685***
General Partnership	0.0787***	-0.0333*	0.0519***	0.0195***	-0.0131*	0.0128***
LLP	0.2389***	-0.1009**	0.2265***	0.0625***	-0.0398***	0.0593***
Stock Corporation	0.4095***	0.0159*	0.4129***	0.1045***	0.0063*	0.1049***
LLC	0.2660***	0.6194***	0.9668***	0.0695***	0.2328***	0.2986***
Cooperative	0.2051***	0.0197	0.1456***	0.0530***	0.0078	0.0371***
Foundation	-1.0156***	-0.0472	-0.9844***	-0.1602***	-0.0186	-0.1613***
For.Aff.(LLC)	0.6659***	0.3651***	0.8412***	0.1957***	0.1410***	0.2551***
For.Aff.(Stock Corp.)	0.8751***	0.2040**	1.0961***	0.2682***	0.0800**	0.3438***
Municipality (Reference: Center)						
Suburban	0.2820***	0.0335***	0.2943***	0.0714***	0.0132***	0.0752***
High-Income	0.1621***	0.0058	0.1721***	0.0412***	0.0023	0.0442***
Periurban	0.2520***	0.0386***	0.2640***	0.0655***	0.0152***	0.0691***
Touristic	-0.1419***	0.0320	-0.1354***	-0.0326***	0.0126	-0.0315***
Industrial Tertiary	0.1460***	0.0358***	0.1526***	0.0367***	0.0141***	0.0387***
Rural Commuter	0.3101***	0.0303*	0.3152***	0.0824***	0.0120*	0.0842***
Rural Mixed	0.3098***	0.0306**	0.3247***	0.0822***	0.0121**	0.0869***
Rural Municipality	0.3211***	0.0508	0.3243***	0.0862***	0.0200	0.0874***
Renewal Region	0.0498***	0.0123	0.0466***	0.0121***	0.0048	0.0114***
Region (Reference: Zürich)						
Geneva Lake	-0.0163*	0.0132	-0.0220**	-0.0039*	0.0052	-0.0053**
Espace Midland	-0.0502***	0.0264**	-0.0392***	-0.0120***	0.0104**	-0.0095***
North-West	-0.0555***	0.0614***	-0.0227**	-0.0132***	0.0242***	-0.0055**
East	-0.0199*	0.0438***	0.0169	-0.0048**	0.0173***	0.0041
Central	0.0213*	0.0460***	0.0536***	0.0052*	0.0181***	0.0132***
Tessin	0.0046	-0.0269	-0.0054	0.0011	-0.0106	-0.0013
Size (Non-linear)	YES	YES	YES	YES	YES	YES
Constant	-0.2986***	-0.2155***	-0.4268***	—	—	—
Observations:	301.465	129.315	290.607	301.465	129.315	290.607

Notes: The binary dependent variable is "1" for the 'affected' plants after treatment ($Y_1|D=1$) and "0" for each of the three 'counterfactuals', i.e. Column (1) is "$Y_1|D=0$", Column (2) is "$Y_0|D=1$" and Column (3) is "$Y_0|D=0$", respectively. Hence, the probit estimation contains observations from Period 0 and Period 1. The symbols *, **, and *** indicate that estimates are significant at the 10%, 5%, and 1% level, respectively. The definitions of the variables are presented in Table 2A.4. The sizes of firms and plants are measured in full time employment units and the coefficients are left out here for the purpose of clarity.

Table 2A.9: Probit Estimates for the Propensity Score (continued)

	Period 2					
	Coefficients			Average Marginal Effects		
Variable	(1)	(2)	(3)	(1)	(2)	(3)
Headquarter	0.1706***	0.2540***	0.4172***	0.0371***	0.0979***	0.0862***
Service Industries	-1.4111***	0.0269***	-1.3759***	-0.4697***	0.0105***	-0.4497***
Legal Form (Reference: "Sole Proprietorship")						
Private Partnership	-0.3687***	-0.0753*	-0.3842***	-0.0729***	-0.0293*	-0.0770***
General Partnership	0.0871***	-0.0589***	0.0270*	0.0206***	-0.0229***	0.0063***
LLP	0.1445***	-0.1738***	0.1398***	0.0349***	-0.0672***	0.0338***
Stock Corporation	0.3672***	0.0535***	0.4213***	0.0886***	0.0208***	0.1017***
LLC	0.1665***	0.9121***	1.2259***	0.0400***	0.3274***	0.3791***
Cooperative	0.1774***	-0.0328	0.0850***	0.0433***	-0.0128	0.0202***
Foundation	-1.1278***	-0.0685	-1.0588***	-0.1584***	-0.0266	-0.1595***
For.Aff.(LLC)	0.6241***	0.4579***	0.9006***	0.1750***	0.1739***	0.2653***
For.Aff.(Stock Corp.)	0.7530***	0.2846***	1.0802***	0.2182***	0.1099***	0.3271***
Municipality (Reference: Center)						
Suburban	0.2885***	0.0610***	0.3153***	0.0695***	0.0238***	0.0768***
High-Income	0.1570***	0.0195	0.1797***	0.0379***	0.0076	0.0439***
Periurban	0.2509***	0.0590***	0.2771***	0.0621***	0.0230***	0.0693***
Touristic	-0.1145***	0.0583**	-0.1044***	-0.0251***	0.0227***	-0.0233***
Industrial Tertiary	0.1605***	0.0473***	0.1669***	0.0386***	0.0184***	0.0404***
Rural Commuter	0.3254***	0.0490***	0.3341***	0.0829***	0.0191***	0.0854***
Rural Mixed	0.3205***	0.0512***	0.3425***	0.0815***	0.0199***	0.0877***
Rural Municipality	0.3595***	0.0761**	0.3596***	0.0933***	0.0297**	0.0932***
Renewal Region	0.0561***	0.0159*	0.0469***	0.0130***	0.0062*	0.0109***
Region (Reference: Zürich)						
Geneva Lake	0.0272***	0.0482***	0.0022	0.0063***	0.0188***	0.0005
Espace Midland	-0.0207**	0.0394***	-0.0264**	-0.0047**	0.0154***	-0.0061***
North-West	-0.0165	0.0743***	-0.0052	-0.0038	0.0289***	-0.0012
East	0.0220**	0.0624***	0.0410***	0.0051**	0.0243***	0.0096***
Central	0.0376***	0.0702***	0.0777***	0.0087***	0.0273***	0.0183***
Tessin	0.0552***	-0.0046	0.0162	0.0129***	-0.0018	0.0038
Size (Non-linear)	YES	YES	YES	YES	YES	YES
Constant	-0.3412***	-0.3679***	-0.5560***	—	—	—
Observations:	307.589	126.253	287.545	307.589	126.253	287.545

Notes: The binary dependent variable is "1" for the 'affected' plants after treatment ($Y_2|D=1$) and "0" for each of the three 'counterfactuals', i.e. Column (1) is "$Y_2|D=0$", Column (2) is "$Y_0|D=1$" and Column (3) is "$Y_0|D=0$", respectively. Hence, the probit estimation contains observations from Period 0 and Period 2. The symbols *, **, and *** indicate that estimates are significant at the 10%, 5%, and 1% level, respectively. The definitions of the variables are presented in Table 2A.4. The sizes of firms and plants are measured in full time employment units and the coefficients are left out here for the purpose of clarity.

Table 2A.9: Probit Estimates for the Propensity Score (continued)

	Period 3					
	Coefficients			Average Marginal Effects		
Variable	(1)	(2)	(3)	(1)	(2)	(3)
Headquarter	0.1518***	0.3083***	0.4719***	0.0333***	0.1147***	0.0927***
Service Industries	-1.4076***	0.0502***	-1.3269***	-0.4696***	0.0191***	-0.4189***
Legal Form (Reference: "Sole Proprietorship")						
Private Partnership	-0.4329***	-0.1274***	-0.4334***	-0.0836***	-0.0480***	-0.0821***
General Partnership	0.0519***	-0.0724***	0.0005	0.0122***	-0.0274***	0.0001
LLP	0.1131***	-0.2112***	0.1133***	0.0271***	-0.0791***	0.0262***
Stock Corporation	0.3606***	0.1479***	0.4914***	0.0872***	0.0559***	0.1149***
LLC	0.2030***	1.2201***	1.5478***	0.0492***	0.4115***	0.4817***
Cooperative	0.0046	-0.1601***	-0.0081	0.0011	-0.0603***	-0.0018
Foundation	-1.1984***	0.1520	-0.9396***	-0.1634***	0.0577	-0.1437***
For.Aff.(LLC)	0.6426***	0.5339***	0.9407***	0.1821***	0.1972***	0.2712***
For.Aff.(Stock Corp.)	0.7684***	0.3574***	1.1722***	0.2246***	0.1344***	0.3497***
Municipality (Reference: Center)						
Suburban	0.3027***	0.0923***	0.3429***	0.0734***	0.0350***	0.0810***
High-Income	0.1514***	0.0157	0.1751***	0.0367***	0.0059	0.0412***
Periurban	0.2697***	0.0968***	0.3096***	0.0675***	0.0368***	0.0754***
Touristic	-0.1038***	0.0921***	-0.0844***	-0.0230***	0.0350***	-0.0183***
Industrial Tertiary	0.1670***	0.0752***	0.1869***	0.0405***	0.0286***	0.0439***
Rural Commuter	0.3287***	0.0787***	0.3508***	0.0843***	0.0299***	0.0870***
Rural Mixed	0.3362***	0.0872***	0.3719***	0.0864***	0.0331***	0.0927***
Rural Municipality	0.3687***	0.1044***	0.3858***	0.0966***	0.0397***	0.0974***
Renewal Region	0.0743***	0.0307***	0.0597***	0.0173***	0.0116***	0.0134***
Region (Reference: Zürich)						
Geneva Lake	0.0024	0.0518***	-0.0037	0.0006	0.0197***	-0.0008
Espace Midland	-0.0371***	0.0398***	-0.0312***	-0.0085***	0.0151***	-0.0069***
North-West	-0.0106	0.0740***	-0.0061	-0.0024	0.0281***	-0.0014
East	0.0251**	0.0787***	0.0542***	0.0058**	0.0299***	0.0122***
Central	0.0379***	0.0931***	0.0964***	0.0088***	0.0354***	0.0221***
Tessin	0.0626***	0.0153	0.0367**	0.0147***	0.0058	0.0083**
Size (Non-linear)	YES	YES	YES	YES	YES	YES
Constant	-0.3527***	-0.5283***	-0.7240***	—	—	—
Observations:	300.023	124.673	285.965	300.023	124.673	285.965

Notes: The binary dependent variable is "1" for the 'affected' plants after treatment ($Y_3|D=1$) and "0" for each of the three 'counterfactuals', i.e. Column (1) is "$Y_3|D=0$", Column (2) is "$Y_0|D=1$" and Column (3) is "$Y_0|D=0$", respectively. Hence, the probit estimation contains observations from Period 0 and Period 3. The symbols *, **, and *** indicate that estimates are significant at the 10%, 5%, and 1% level, respectively. The definitions of the variables are presented in Table 2A.4. The sizes of firms and plants are measured in full time employment units and the coefficients are left out here for the purpose of clarity.

Chapter 3

Employment Growth in the Course of Mergers and Acquisitions

joint with Dirk Burghardt

3.1 Introduction

A firm's employees are an important stakeholder group in the process of mergers and acquisitions. Acquiring firms are concerned about the cultural fit between the old and new parts of the workforce, and additional employees increase management complexity. Furthermore, new points of personal contact and cooperation need to be established. At the same time, the employees of the target firm undergo reorganization and face a new employer with different standards and expectations. The resulting insecurity is even more intense with the involvement of foreign investors. In some cases, the situation even turns into a public policy concern through public demonstrations by employees who feel threatened with mass layoffs. Apart from anecdotal evidence, however, very little is known about how mergers and acquisitions affect the employment in newly acquired target firms.[1]

This paper uses a unique complete inventory count of firm establishments in Switzerland to study the changes in employment in the course of mergers and acquisitions.[2]

[1] A vast amount of research does exist, however, on the effects of mergers and acquisitions on shareholder value. Recent studies include Fuller et al. (2002), Graham et al. (2002), and Moeller et al. (2005). See Martynova and Renneboog (2008) for a survey.

[2] By firm establishment, establishment, or plant, the present study refers synonymously to a building or building complex of a firm which can either be a single-plant firm, the headquarters of a multi-plant firm, or a companion plant of a multi-plant firm.

Out of about 350,000 establishments that constituted the Swiss services and manufacturing sector in the year 2001, we identify 5,389 firm establishments that were acquired by another firm in the subsequent four years. This number also includes very small plants, which are typically disregarded by other studies. Our empirical model relates the growth in employment of each establishment to a number of explanatory variables: at first, variables which have been identified as general growth determinants by the literature, such as the initial size or the age of an establishment, are included. More importantly, we investigate how the status of being "recently acquired" influences growth outcomes. To cope with endogeneity concerns, in a robustness check we employ the idea that among multi-plant mergers—where not just one but several different plants are acquired at the same time—the acquisition of an individual plant is treated as exogenous.

Four results stand out. First, we find that the growth of (surviving) firm establishments decreases with their initial size and age. For establishments in Switzerland, we can thus reject Gibrat's Law of proportionate growth. The next section will show how this result contributes to an ongoing discussion on the growth of firms and firm establishments in general. Second, turning to the analysis of mergers and acquisitions, we find that the size of the acquiring firm is positively related to the growth of a newly acquired plant, while the (combined) size of the newly acquired establishments is negatively related to its growth. In other words, the size differential between acquirer and target is an important determinant for the internal growth of a newly acquired establishment's workforce. This finding is new to the literature. There are several possible explanations, such as that the acquiring firm has constrained resources, which means that with high acquisition costs, hiring additional employees is financially restricted and with lower acquisition costs, hiring additional employees is comparatively unrestricted. It is also possible that with relatively large acquisitions, firms simultaneously increase their market power to a larger extent. Subsequent production is reduced, requiring less employees. Furthermore, managerial capacities may be exhausted and thus hiring tasks delayed. Third, mergers and acquisitions in export oriented industries and within related industries are associated with adverse effects on employment growth. These findings may result from a higher competitive pressure in export industries and more possibilities for streamlining measures when similar businesses merge. Fourth, we find that foreign-owned plants on average grow more rapidly than other plants which might be related to a technology transfer from their foreign owners.

The remainder of this paper is structured as follows. Section 3.2 presents some theoretical considerations and provides a brief review of the strands of literature this study contributes to. Section 3.3 describes our data. Section 3.4 introduces the empirical model. Section 3.5 provides our regression results and their discussion. Section 3.6 presents some further robustness checks. Section 3.7 concludes, and suggests directions for future research.

3.2 Related Literature

Our first result—on the relationship between the growth of an establishment and its initial size and age—contributes to an ongoing discussion on the growth of firms and firm establishments in general. It is preparatory to analyzing how mergers and acquisitions are related to growth outcomes. The debate on firm growth may have started with the formulation of Gibrat's Law of proportionate growth in 1931. Gibrat (1931) stated that the growth of a firm or of an establishment is uncorrelated with its initial size. This (nonexisting) relationship between initial size and growth was intended to be helpful for the mathematical modeling of firm dynamics. Indeed, Gibrat (1931) found it to be empirically true for his data on French manufacturing establishments in 1920 and 1921. Other early studies accepted his findings at least as a first approximation (see Sutton (1997) for a survey).

Later studies, by contrast, tend to find an inverse relationship between growth and size or age—at the firm level (Hall, 1987; Evans, 1987a,b; Dunne and Hughes, 1994; Harhoff et al., 1998) as well as at the level of individual establishments (Dunne et al., 1989; Blonigen and Tomlin, 2001)[3]. An explanation for this inverse relationship is the theory of learning over time, as proposed by Jovanovic (1982). The present study is the first to provide empirical evidence for Switzerland. In addition, it is one of the few that also take into account the services sector and very small firms.

Our second result—on the effect on employment growth of the size differential between the acquirer and the target—extends the previous empirical literature which analyzes the employment effects of mergers and acquisitions by an important determinant. So far, a coherent theory that predicts the employment effects of mergers and acquisitions does not exist. The reason might be that it is indeed difficult to capture all

[3]Note that total firm growth can be decomposed into internal establishment growth and external growth through the acquisition of additional establishments. Thus, the results for aggregate internal establishment growth are not necessarily equivalent to firm growth.

relevant mechanisms within a single theoretical model. Individual mergers take place for different motives, implying also different effects on employment. A study by Andrade et al. (2001) classifies the possible reasons for mergers and acquisitions into five categories: 1. efficiency related reasons, 2. the creation of market power, 3. market discipline, 4. agency costs, and 5. opportunities for diversification. For example, a merger takes place for efficiency related reasons. Typically, this implies that there exist overlapping job functions that can be cut. In the course of the merger, employment then gets reduced in order to realize the intended efficiency gains.[4] Suppose, by contrast, two businesses merge because of the empire building tendencies of their managers as a particular form of agency costs. The managers are then interested in hiring even more employees for the newly acquired plant.[5] Suppose, as a third example, firms use mergers as a vehicle to diversify their range of products. In an extreme case of very different products, there are no overlapping job functions that could be cut. For such mergers, we would expect that employment does not change at all.

Previous empirical studies indeed provide a mixed picture concerning the overall effect of mergers and acquisitions on employment. A number of studies find negative effects of corporate takeovers on employment. Conyon et al. (2002) suggest that firms in the United Kingdom reduce joint output as well as their overall use of labor after a merger. For related firms and hostile mergers, these effects are found to be particularly strong. Gugler and Yurtoglu (2004) find no significant effect for firms in the United States, but negative effects for firms in Europe. They attribute this difference to more rigid labor markets in Europe. Also a study by Bhagat et al. (1990) falls into the group of studies which find negative employment effects of corporate takeovers. In addition, they observe that white-collar employees are disproportionately affected by layoffs, many of them due to consolidations of headquarters. In a similar manner, Lichtenberg and Siegel (1990) differentiate between production establishments and auxiliary establishments where top managers, administrators, and R&D personnel are employed. According to their study, ownership changes lead to a much lower employment growth in auxiliary establishments compared to production establishments.

Mixed effects depending on the type of acquisition are found in a sample of US manufacturing firms in the state of Michigan by Brown and Medoff (1988). They define three types of acquisition: asset-only sales, where ownership changes take place without integration with another firm; simple sales, where firms acquire assets of other

[4]For example, Farrell and Shapiro (1990) use this motive.

[5]Marris (1963) and Jensen (1986) are good examples here.

firms without absorbing the workforce; and mergers, where most workers of the acquired firm are absorbed or combined with those of the acquirer. For firms that are part of simple sales or mergers, they find that employment decreases. For firms that are part of asset-only sales, they find the opposite.

A number of other studies tend to find positive effects of acquisitions on employment. According to an early study by Green and Cromley (1982), employment increases in the period following a horizontal merger. Using plant-level data for the US manufacturing sector, McGuckin and Nguyen (2001) find positive overall effects of changes in ownership on jobs and wages as well. However, this finding does not hold for the group of larger plants where ownership changes are actually associated with job losses. Furthermore, acquired plants are found to have a smaller probability of closing.

Our data set reveals that newly acquired firm establishments on average grow more slowly than other establishments. This puts our study into the first group of the articles described above. However, just looking at the overall effect hides some important heterogeneity. In particular, we find that the size differential between the acquiring firm and the newly acquired establishments matters for the growth of these establishments. On the one hand, establishments that were acquired by larger acquiring firms grow more rapidly than establishments that were acquired by smaller firms. On the other hand, we find that establishments acquired by acquiring firms that have to integrate a large combined size of new establishments grow less rapidly than establishments with acquirers of the opposite type. In sum, the size differential between the acquiring firm and the total integration size matters for the growth of an acquired establishment: those establishments profit that get acquired by a firm that is considerably larger than their own size plus the size of the other plants the firm acquired. This distinction is new to the literature.

We explain our finding by financial constraints through market imperfections (e.g., limited liability and moral hazard risk). Investment possibilities depend on internal firm resources. Thus, if (financial) resources are exploited for external firm growth through mergers and acquisitions, there only remains a low potential for internal growth through hiring additional employees.[6] As a result, a high integration size compared to the size of the acquirer should lead to lower internal employment growth in the (acquired) plants. Another explanation is constrained managerial capacity's leading to a delay in hiring tasks.

[6]For surveys on financing constraints and firm dynamics, see, for example, Hubbard (1998) and Stein (2003).

As a third key result, we observe important industry specific differences in the relationship between mergers and acquisitions and employment growth. First, compared to other industries, mergers and acquisitions in export oriented industries are associated with adverse effects on employment growth. This result might be driven by the more competitive environment for firms in sectors with exposure to international trade (as modeled by Melitz (2003), for example). In the course of acquisitions, more synergy effects are realized than in environments with less competitive pressure. Second, mergers and acquisitions within related industries have adverse effects on employment growth. In this case, higher synergy effects might get realized not because of competitive pressure, but because of the greater possibilities for rationalization which firms obtain when merging with similar businesses. This result is consistent with what Conyon et al. (2002) find. Another explanation is the creation of market power, allowing the merging firms (insiders) to internalize their competitive externalities in the product market through a reduction in output (Farrell and Shapiro, 1990). Simultaneously, outsiders have an incentive to expand output, implying lower market shares for the insiders. A recent study by Gugler and Siebert (2007) investigates the trade-off between market power and efficiency effects through changes in market shares, and finds the latter to be prevalent in the semiconductor industry.

3.3 Data

3.3.1 Data Source and Data Preparation

Our analysis is based on a complete inventory count of Swiss firms in the secondary and tertiary sectors, collected by the Swiss Federal Statistical Office (BFS). The goal of the regular collection of this data is the registration of all economic production units with their economic, social, and geographical characteristics. Collection takes place via a questionnaire which is mailed to the firms. Participation is mandatory for all firms in Switzerland. The survey captures, among other things, the location and sector of economic activity of individual units as well as the number of employees, by level of employment, gender, and nationality. In our paper, we use the data from 2001 and 2005.

For both years, we observe the unique identification number of a plant as well as the number of the firm which the plant belongs to. An acquisition is identified in the data by the change of the firm number of an individual plant from 2001 to 2005. In

addition, the resulting firm must consist of at least two plants in 2005. This additional requirement is used to distinguish acquisitions where a plant gets integrated into a new institutional unit from simple ownership changes.

Table 3.3.1: Acquisitions in the Swiss Manufacturing Sector

NOGA	Industry	Plants in 2001	Acquisitions 2001–2005	Acquisition rate (percent)
15	Food Products and Beverages	3,188	107	3.36
16	Tobacco Products	18	0	0.00
17	Textiles	766	4	0.52
18	Wearing Apparel	983	19	1.93
19	Leather Products	309	0	0.00
20	Wood and Cork Products	6,578	13	0.20
21	Paper, Pulp and Paper Products	251	3	1.20
22	Publishing and Printing	4,697	30	0.64
23	Coke, refined Petroleum Products	11	0	0.00
24	Chemicals and Chemical Products	1,143	36	3.15
25	Rubber and Plastic Products	894	6	0.67
26	Other non-metallic Mineral Prod.	1,521	32	2.10
27	Production of Basic Metals	296	5	1.69
28	Fabricated Metal Products	8,253	27	0.33
29	Machinery and Equipment	3,689	32	0.87
30	Office Machinery and Computers	145	0	0.00
31	Electric Machinery and Apparatus	1,142	13	1.14
32	Radio, TV, Communic. Equipment	689	8	1.16
33	Medical and Precision Instruments	3,552	29	0.82
34	Motor Vehicles, Trailers	195	1	0.51
35	Other Transport Equipment	424	3	0.71
36	Furniture, Jewelry, etc.	3,970	10	0.25
37	Recycling	357	4	1.12
	All Manufacturing Industries	43,071	382	0.89

Notes: Shown is the total number of plants in 2001, the number of plants acquired between 2001 and 2005, and the resulting acquisition rate (in percent) for each industry. Plants are classified according to the industry of their parent firm. Industries are distinguished at a 2 digit level, following the NOGA (Nomenclature Générale des Activités économiques) 2002 classification of the Swiss Federal Statistical Office.

3.3.2 Descriptive Statistics

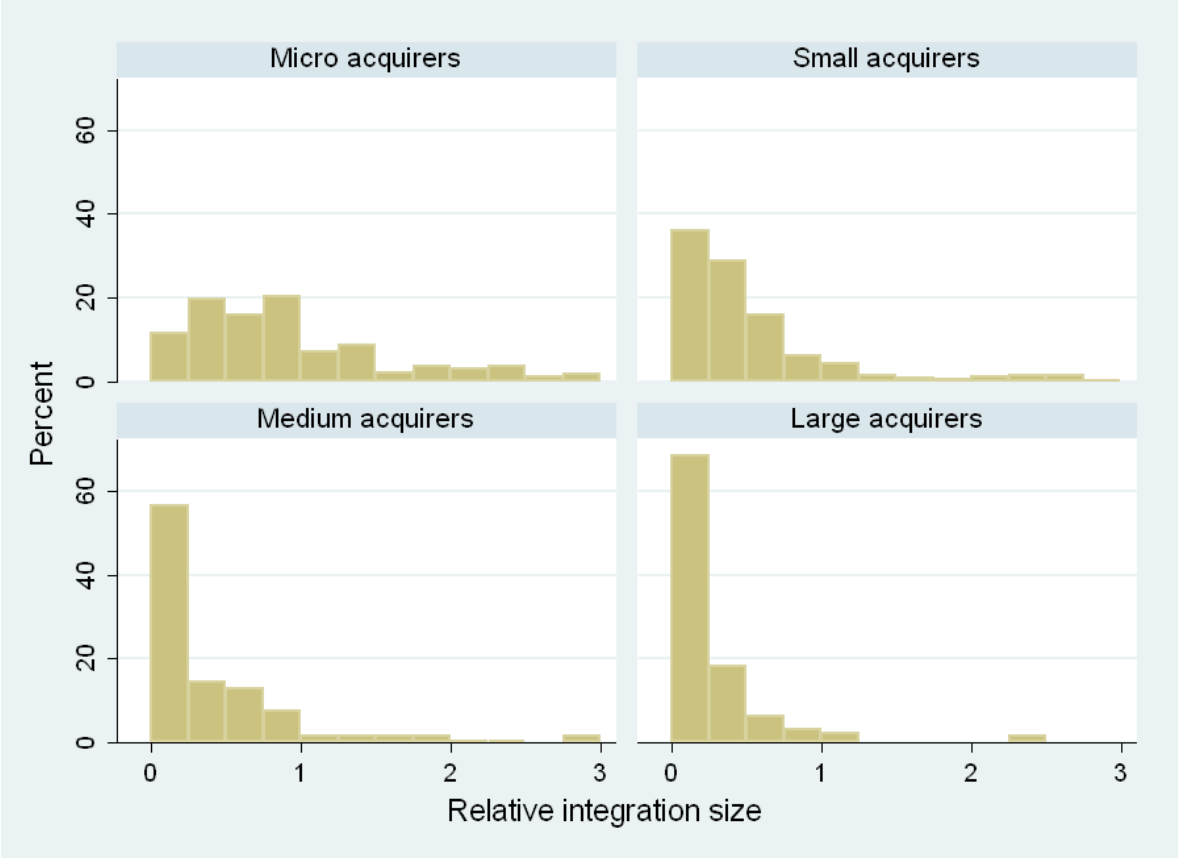
Using the above definition of mergers and acquisitions, we next present some descriptive statistics to get an impression of what kind of acquisitions this study is actually based on. Table 3.3.1 presents the total number of plants in 2001, the number of plants acquired between 2001 and 2005, and the acquisition rate for the manufacturing sector, split up by individual industries. Table 3.3.2 does the same for the services sector. We define the acquisition rate as the number of plants that are acquired from 2001 to 2005, divided by the total number of plants in 2001.

Table 3.3.2: Acquisitions in the Swiss Services Sector

NOGA	Industry	Plants in 2001	Acquisitions 2001–2005	Acquisition rate (percent)
40	Energy Supply	453	19	4.19
41	Water Supply	29	0	0.00
45	Construction	36,108	162	0.45
50	Vehicle Services	15,308	138	0.90
51	Wholesale and Commission Trade	20,877	249	1.19
52	Retail Trade	46,453	1,103	2.37
55	Hotels and Restaurants	26,974	676	2.51
60	Land and Pipeline Transport	8,579	89	1.04
61	Water Transportation	102	0	0.00
62	Air Transportation	240	6	2.50
63	Auxiliary Transport Activities	3,996	183	4.58
64	Post and Telecommunications	1,170	188	16.07
65	Banks and Funds	3,951	488	12.35
66	Insurance Companies	2,823	290	10.27
67	Banking Business Activities	3,718	65	1.75
70	Real Estate Activities	4,480	22	0.49
71	Renting of Goods and Chattels	1,012	19	1.88
72	Data Processing and Data Bases	11,519	39	0.34
73	Research and Development	497	5	1.01
74	Other Business Activities	64,983	670	1.03
80	Education	4,913	37	0.75
85	Health and Social Work	23,016	283	1.23
90	Sewage and Waste Treatment	468	8	1.71
91	Membership Organizations	3,667	135	3.68
92	Cultural and Sporting Activities	6,014	36	0.60
93	Other Service Activities	14,060	97	0.69
	All Services Industries	305,410	5,007	1.64

Notes: See Table 3.3.1.

Figure 3.1: Relative Integration Size by Acquirer Size



Notes: Shown is the percentage of acquiring firms that have a certain relative integration size (by acquirer size group). Relative integration size is defined as (Integration size 2001–2005)/(Acquirer size 2001). It is 1 if the acquirer had the same size in 2001 as all the plants acquired from 2001 to 2005 taken together. It is smaller than 1 if the acquirer is larger than all acquired plants. Only acquirers which started operating before September 2001 and with a relative integration size below 3 are considered. Based on the employment in full-time-equivalents (FTE), the acquirers are classified into micro (0–10 FTEs), small (10–50 FTEs), medium (50–250 FTEs), and large (above 250 FTEs), respectively.

In the manufacturing sector, 382 plants out of 43,071 plants were acquired, leading to an acquisition rate of 0.89%. The highest number and also rate of acquisition can be found in the industries for food and luxury food stuff and chemicals. In the services sector, 5,007 out of 305,410 plants were acquired, leading to an acquisition rate of 1.64%, almost twice as much as in the manufacturing sector. Here, the highest acquisition rates can be found in the industries for post and telecommunications, banks, and insurance companies. Retail trade is the industry with the highest number of acquired plants, however. In sum, Switzerland had 348,481 plants in 2001, of which 5,389 were newly acquired by another firm between 2001 and 2005.

Figure 3.1 shows, by acquirer size group, the percentage of acquiring firms which have a certain relative integration size. Overall, we can say that most acquiring firms

acquire targets which are in sum smaller than themselves (relative integration size smaller than 1). Still, patterns are somewhat different depending on the size group the acquirer belongs to. While more than 60% of large acquiring firms acquire targets which are in sum smaller than 25% of their initial own size, the distribution broadens considerably for smaller acquirers: many micro acquirers also acquire targets which have in sum up to 50%, 75%, or 100% of their own size. Some targets are even larger than the acquirers themselves (relative integration size larger than 1). A first explanation might be a better availability of relevant targets.

3.4 Empirical Model

Our empirical model is an OLS specification similar to that of Brown and Medoff (1988) and McGuckin and Nguyen (2001). In its main version, it takes the form

$$\begin{aligned}\ln\left(Size_{05}/Size_{01}\right) = \beta_0 \quad &+ \quad \beta_1 A + \beta_2 \ln Size_{01} + \beta_3 (\ln Size_{01})^2 + \beta_4 Age7 + \\ &+ \quad \beta_5 Age10 + \beta_6 HQ + \beta_7 Foreign + \beta_8 Export + \\ &+ \quad \beta_9 A \times \ln ASize + \beta_{10} A \times \ln ISize + \\ &+ \quad \beta_{11} A \times Age7 + \beta_{12} A \times Age10 + \beta_{13} A \times HQ + \\ &+ \quad \beta_{14} A \times Foreign + \beta_{15} A \times Export + \beta_{16} A \times Related + \\ &+ \quad \textstyle\sum_{d=1}^{26} \beta_{17,d} Industry_d + \sum_{g=1}^{7} \beta_{18,g} Region_g + \epsilon \end{aligned} \tag{3.1}$$

where the dependent variable reflects the growth of a plant in terms of employment from 2001 to 2005: We divide the size of a plant in 2005 by the size of this plant in 2001, with size being measured by the number of full-time equivalent employees. Then, the natural logarithm of the resulting expression is taken in order to get an approximate percentage effect.

As explanatory variables we have, first of all, A, which is a dummy denoting the acquisition status of a plant: it equals 1 if a plant was acquired between 2001 and 2005, and zero if not. $Size_{01}$ is the total number of employees of a plant in 2001 measured in full-time equivalents. We then take the natural logarithm of this value since we want to talk about growth rates and also include the square of the logarithm in order to take non-monotonic behavior into account. Next, there are three Age dummies, which are constructed as follows: $Age4$ equals 1 if a plant began operation between October 1998 and September 2001, that is, if it had been in existence from 4 to 7 years by 2005. $Age7$ equals 1 if a plant began operation between October 1995 and September 1998, that is,

if it had been in existence from 7 to 10 years by 2005. $Age10$ equals 1 if a plant began operation before October 1995, that is, if it had been in existence for 10 years or more by 2005. Otherwise the dummy equals zero. Note that $Age4$, which equals 1 for the youngest plants in this analysis, is used as a reference variable and thus is not included in Equation (3.1). In order to find out a plant's age, we check the existence of a plant in surveys from 1995 and 1998 (due to changes in the coding system of firm numbers, we could not use these survey years for other parts of the analysis). HQ is a dummy which catches the headquarters status of a plant in 2001. It equals 1 if a plant is a single-plant firm or the headquarters of a multi-plant firm, and zero otherwise. $Foreign$ is a dummy which equals 1 if a plant is owned (at least partly) by foreign capital in 2001, and zero if not (or if foreign ownership is unknown, as in some cases). Finally, $Export$ is a dummy which equals 1 if a plant belongs to an industry which an above average share of the firms exports, and zero otherwise.

In addition to these individual variables, nine other variables are included in interaction with A, the acquisition status variable of a plant. $A \times \ln ISize$ denotes the interaction with the integration size, that is, the sum of the number of employees (in full-time equivalents) in 2001 of all plants the acquirer of a plant acquired between 2001 and 2005. $A \times \ln ASize$ is the interaction of being acquired with the acquirer size, that is, the total number of employees of the acquiring firm of a plant in 2001. Loosely speaking, these two interactions terms are used to relate the internal growth of a plant which was acquired to the size differential between its acquirer and the total size of all of the targets (acquisitions) this acquirer has to integrate.

Furthermore, interactions of A with $Age7$ and $Age10$ are included. $A \times HQ$ and $A \times Foreign$ are interactions of A with the headquarters status and foreign ownership status as defined above. $A \times Export$ is the interaction of A with a dummy which equals 1 if a plant belongs to an export oriented industry as defined above and zero otherwise. It thus catches acquisitions in industries which are open to international trade. $A \times Related$ refers to acquisitions in related industries. $Related$ equals 1 if the headquarters plant of the acquiring firm operates in the same industry in 2001 as a plant which was acquired. Finally, we included 26 industry and 7 greater region dummies. Such a dummy equals 1 if a plant operates in a certain industry or region and zero if not.

We estimate four models. As a start, Model (1) is a restricted estimation without interaction terms, to identify an overall effect of being acquired, $A = 1$, on plant growth in terms of employment. Model (2) is our main model, including all interaction

variables. Finally, there are two estimations with a restricted sample. Model (3) only includes firms from the manufacturing sector; Model (4) only includes firms from the services sector.

Before we present the results, two limitations of our approach should be noted. First, it is important to keep in mind that we interpret a special part of the sample. To calculate growth rates we restricted our analysis to plants that existed at both points in time, 2001 and 2005. Small firms with slow or negative growth might be more likely to close than large firms with these characteristics, i.e., disappear from the sample in 2005. We thus might have a sample selection which biases the growth of small firms upward, because the worst performing ones drop out.

Second, a general concern with this type of study is endogeneity. Our estimates are consistent if A is not correlated with the error term, that is, if it is an exogenous variable. This assumption might be invalid. Previous studies have mostly ignored this issue. Only McGuckin and Nguyen (2001) provide a solution, by using an instrumental variable estimation with relative plant productivity growth as an instrument for their equivalent of our A variable. In Section 3.6, we suggest a different but related robustness check by looking at a sub-sample of "complete multi-plant mergers" only. For these mergers, it is particularly reasonable to assume that the takeover of an individual plant is exogenous, since merger decisions will typically be related to the advantages of the overall package the target is perceived to come with.

3.5 Results and Discussion

3.5.1 Establishment Growth and Size and Age

Table 3.5.1 presents our estimates for Equation 3.1 and its modifications. A first result contributes to an ongoing debate on the growth of firms and firm establishments in general. We find that plant growth decreases with plant size and plant age (at a decreasing rate) (Result 1). Throughout all regressions, we find negative coefficients that are statistically significant for the size of a plant in 2001, $\ln Size_{01}$. Furthermore, the coefficients for $(\ln Size_{01})^2$ turn out to be positive, indicating a decreasing negative impact of size on growth for larger plants. Our coefficients for the plant age dummies, $Age7$ and $Age10$, suggest the same type of relationship between growth and age. For plants in Switzerland, we can thus reject Gibrat's Law of proportionate growth (which states that growth is independent of size) (Gibrat, 1931; Sutton, 1997). By contrast,

Table 3.5.1: Major Regression Estimates

	Dependent variable: $\ln(Size_{05}/Size_{01})$			
Independent variable	All industries (1)	All industries (2)	Manufacturing (3)	Services (4)
$\ln Size_{01}$	-0.1704***	-0.1708***	-0.1191***	-0.1814***
	(0.002)	(0.002)	(0.005)	(0.002)
$(\ln Size_{01})^2$	0.0273***	0.0276***	0.0176***	0.0302***
	(0.001)	(0.001)	(0.001)	(0.001)
$Age7$	-0.0437***	-0.0432***	-0.0615***	-0.0407***
	(0.004)	(0.004)	(0.010)	(0.004)
$Age10$	-0.0562***	-0.0558***	-0.0924***	-0.0509***
	(0.003)	(0.003)	(0.008)	(0.003)
HQ	-0.0412***	-0.0411***	-0.0073	-0.0443***
	(0.003)	(0.004)	(0.013)	(0.004)
$Foreign$	0.0460***	0.0449***	0.0047	0.0538***
	(0.007)	(0.007)	(0.017)	(0.008)
$Export$	-0.1211***	-0.1151***	-0.0028	-0.1597***
	(0.029)	(0.029)	(0.012)	(0.047)
A	-0.0342***	0.1636***	0.0178	0.1647***
	(0.007)	(0.037)	(0.198)	(0.038)
$A \times \ln ASize$		0.0300***	0.0146	0.0310***
		(0.004)	(0.020)	(0.005)
$A \times \ln ISize$		-0.0468***	-0.0417**	-0.0485***
		(0.004)	(0.017)	(0.004)
$A \times Age7$		-0.0272	-0.3311**	-0.0180
		(0.025)	(0.134)	(0.026)
$A \times Age10$		-0.0259	-0.0089	-0.0266
		(0.019)	(0.093)	(0.020)
$A \times HQ$		-0.0332*	0.0501	-0.0304*
		(0.017)	(0.062)	(0.018)
$A \times Foreign$		0.0003	0.2957***	-0.0357
		(0.034)	(0.110)	(0.036)
$A \times Export$		-0.1051***	-0.0452	-0.0954***
		(0.016)	(0.137)	(0.016)
$A \times Related$		-0.0667***	-0.1158	-0.0649***
		(0.020)	(0.073)	(0.022)
Constant	0.3339***	0.3273***	0.1649***	0.3312***
	(0.028)	(0.028)	(0.017)	(0.028)
Industry dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
Observations:	262,032	262,032	33,457	228,575
R-squared:	0.047	0.048	0.039	0.049

Notes: Only surviving plants are considered. To account for cases where the acquiring firm did not exist in 2001 and thus values for *ASize* and *Related* are not available, missing dummies are included. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

our results confirm more recent studies that find an inverse relationship between growth and size or age (Dunne et al., 1989; Blonigen and Tomlin, 2001). An explanation for the relationship is the theory of learning over time (Jovanovic, 1982). Note, however, that plant growth is different from total firm growth. Total firm growth can be decomposed into internal (plant) growth and external growth through mergers and acquisitions. While our results do not contradict studies that find an inverse relationship between growth and size or age for firms so far (Hall, 1987; Evans, 1987a,b; Dunne and Hughes, 1994; Harhoff et al., 1998), taking external growth into account might still do so, since we found that mergers and acquisitions are more prevalent among large firms. For example, Geroski and Gugler (2004) find Gibrat's Law to hold for large and mature companies and confirm simultaneously an inverse relationship for small and young ones. We leave this point open for further research.

3.5.2 The Size Differential between Acquirer and Target Plants

Looking at the coefficient for A in regression (1), we find that, overall, acquired plants grow less rapidly than other plants (Result 2a). Such an adverse effect of acquisitions on growth is in line with Conyon et al. (2002), Gugler and Yurtoglu (2004), Bhagat et al. (1990), and Lichtenberg and Siegel (1990) as outlined above. However, this finding hides some important heterogeneity in the data which will be discussed in the next sections by introducing additional variables.

As a main result, we find that the larger the acquiring firm is compared to the combined size of the plants to be integrated, the stronger the plants grow following an acquisition (Result 2b). From the positive coefficients for $A \times \ln ASize$, i.e., the interaction of acquisition status with acquirer size, we can draw the following conclusion: plants which were acquired by larger acquiring firms grew more rapidly than plants which were acquired by smaller acquiring firms. From the negative coefficients for $A \times \ln ISize$, i.e., the interaction of acquisition status with the combined size of the plants to be integrated by a certain plants' acquirer, we can conclude that plants which were acquired by acquiring firms that have to integrate a large combined size of plants grew less rapidly than plants with acquirers of the opposite type. In sum, and as a central result, the size differential between the acquiring firm and the total integration size matters for the internal growth of an acquired plant: those plants profit which are acquired by a firm that is considerably larger than their own size plus the size of the other plants the firm acquired.

Based on the fact that investment possibilities are dependent on internal firm resources, we explain this finding by financial constraints through market imperfections (e.g., limited liability and moral hazard)[7]. Exploiting their resources for external firm growth (through mergers and acquisitions), these are then unavailable for internal growth through hiring additional employees. These resources include also managerial capacities, which may be exhausted through acquisitions, thus delaying hiring tasks. As a result, a high integration size compared to the size of the acquirer should lead to lower internal employment growth in the acquired plants.

Looking at the case where $\ln ASize$ equals $\ln ISize$, that is, a firm doubles its size through acquisitions, there is still an adverse effect on growth. The realization of synergy effects in the form of rationalizing overlapping employee positions is a reasonable explanation. The effect becomes positive as soon as $\ln ISize$ is at least 25% smaller than $\ln ASize$. This might especially represent the case where mature firms buy smaller highly innovative firms with few overlapping functions but strong growth potentials.

3.5.3 Acquisitions in Export Oriented and Related Industries

In addition to the previous results, we observe important industry specific differences in the relationship between mergers and acquisitions and employment growth. First, compared to other industries, mergers and acquisitions in export oriented industries are associated with adverse effects on employment growth (Result 3a). This result in particular holds for the services sector: the coefficient of $A \times Export$ is negative and highly significant. For the manufacturing sector the coefficient turns out to be negative, but insignificant. This result might be driven by the more competitive environment for firms in sectors with exposure to international trade (as modeled by Melitz (2003), for example). In the course of acquisitions, more synergy effects are realized than in environments with less competitive pressure. Recent empirical evidence on the existence of a relationship between the intensity of competition and mergers has been provided by Buehler et al. (2005), finding this relationship to be positive.

Second, mergers and acquisitions within related industries have adverse effects on employment growth (Result 3b). As for the previous result, we find a negative and highly significant coefficient for $A \times Related$ for the services sector and a negative but insignificant coefficient for the manufacturing sector. In this case, higher synergy effects might be realized not because of competitive pressure, but because the greater

[7] For surveys on financing constraints and firm dynamics see, for example, Hubbard (1998) or Stein (2003).

possibilities of rationalization which firms obtain when merging with similar plants. This is consistent with Conyon et al. (2002). Another explanation is the creation of market power allowing the merging firms to internalize their competitive externalities in the product market through reduced production.

3.5.4 The Role of Foreign Investors and Further Results

It also turns out that headquarters of multi-plant firms grow less rapidly than their other plants. In addition, acquired plants with headquarters status grow less rapidly than other acquired plants (Result 4). In all regressions, the coefficient for the HQ variable is negative. It is highly significant for the regression which includes all industries, as well as for the services sector alone. A reason might be that auxiliary headquarters services (such as marketing or accounting) usually do not need to grow as rapidly as the full institutional unit when expanding production and services to serve additional customers. Surprisingly, however, the effect is statistically insignificant in the manufacturing sector alone.

Furthermore, acquired plants with headquarters status, i.e., where $A \times HQ$ equals 1, grow less rapidly than other acquired plants. This result is consistent with Bhagat et al. (1990) and Lichtenberg and Siegel (1990), who find that in particular white-collar worker and auxiliary plants are affected by layoffs following mergers and acquisitions. However, the coefficient in the regression with only the manufacturing sector is insignificant.

As a last result, we find that foreign-owned plants grow more rapidly than plants endowed only with domestic capital. Compared to Swiss plants, the acquisition of foreign-owned plants is positively related to their growth in the manufacturing sector. The coefficient for $A \times Foreign$ is positive and highly significant for this sector. In all regressions, the coefficient for the $Foreign$ variable is positive. However, it is not statistically significant for the manufacturing sector alone. Thus, this result again especially holds for the services sector. An explanation might be that foreign-owned plants benefit from technology transfer from their foreign owners. While increasing productivity, firms have high incentives to keep their employees: first, training staff in new technologies is costly, and second, technology spill-over effects to competitors can be constrained (see, for example, Teece (1986), Görg and Strobl (2005), or Görg and Greenaway (2004)).

3.6 Complete Multi-Plant Mergers

As indicated in Section 3.4, a concern with our regression model is the potential endogeneity of the acquisition variable A, which would lead to regression estimates that are not consistent. In particular, we think of omitted variables (or unobserved heterogeneity) as the channel for endogeneity. Omitted variables could be variables on relevant plant characteristics, such as an indicator for the talent of a plant's management. Talented management might be crucial for the growth of a plant. At the same time, talented management in a target plant might also be decisive for the acquisition status: acquirers might want to select specifically those plants as a target which have exceptional growth prospects thanks to their management. If this were true, and if we can not control for talent in our regression, A would be correlated with the error term ϵ and our regression estimates would be inconsistent. In the example of talented management, the coefficient for A would be biased upwards.

A potential solution to this concern is an instrumental variable estimation. Unfortunately, an ideal instrumental variable for A is typically not readily available for our kind of study. Most previous studies actually ignored this issue. However, an acquired plant's status of being part of a "complete multi-plant merger" is a reasonable candidate, and can be constructed with our data. We define such a merger as a standard merger if it fulfills two additional conditions. First, the merger includes the takeover of at least one complete firm, that is, a firm with all of its plants. Second, the target firm consists of at least four individual plants. The underlying idea is to avoid cherry-picking with regard to the unobserved heterogeneity at the plant level: For complete multi-plant mergers it is particularly reasonable to assume that the takeover of an individual plant is exogenous, since merger decisions will typically be related to the advantages of the overall package the target is perceived to come with. Note that concerning our definition of complete multi-plant mergers, there is a trade-off. On the one hand, requiring a higher number of plants to be part of the target makes the selection of a specific plant more random. On the other hand, the observed sub-sample of acquired plants gets further reduced with a more rigorous definition. In the end, requiring at least four plants seems to be appropriate: out of 5,389 plants that were acquired according to our standard merger definition, 271 plants still fulfilled our additional requirements.

Table 3.6.1 presents the regression results for such complete multi-plant mergers, with A now being the instrumental variable. As in Model (1), Model (5) does not include interaction terms. It turns out that the regression coefficient for A is somewhat

higher but still similar in magnitude to Model (1) and still negative and significant (-0.0523, significant at the 10% level compared to -0.0342, significant at the 1% level in Model (1)). Thus, our results as derived from Model (1) above can be qualitatively confirmed. In addition, the stronger magnitude of the coefficient for A suggests that unobserved characteristics may indeed play a role and the previous result in Table 3.5.1 may actually constitute a lower bound for the overall employment loss. Model (6) includes all interaction terms and industries as in Model (2) above. As in (1), there is almost no change in the coefficients for establishment size, age, headquarters status, foreign ownership, or export. The coefficients for the acquisition status and its interaction terms with size, however, now become insignificant. The same holds for the other interaction terms. Presumably the reduced number of mergers that we look at plays a major role. We obtain very similar results (which are available upon request) when changing the number of plants that the target firm is required to consist of.

3.7 Conclusion

This paper examines how mergers and acquisitions affect employment growth in newly acquired plants. Previous research has been concerned mostly with value creation for shareholders. Based on comprehensive plant-level data from Switzerland, this paper sheds light on employees as an important stakeholder group. Our main aim is a better understanding of the future (employment) prospects from an employee's perspective in the course of a merger or acquisition.

Our findings show that the size differential between the target and the acquirer is an important determinant for employment growth. In particular, we find that a larger size of the acquiring firm has a beneficial effect on employment growth, while a larger size of the acquired plants (target) has an adverse effect. We offer several explanations such as constraints on the financial resources of the acquiring firm: high acquisition costs restrict the potential of hiring additional employees and with lower acquisition costs, hiring additional employees is comparatively unrestricted. Other explanations include market power effects and exhausted managerial capacities. While this distinction is new to the literature, we also confirm some important findings of previous studies. Concerning the general relationship between plant characteristics and plant growth, three results stand out. First, we find that the plant growth decreases with plant size and plant age. Thus, Gibrat's Law of proportionate growth can be rejected for plants in Switzerland. Second, headquarters of multi-plant firms grow more slowly than

Table 3.6.1: Supplementary Regression Estimates

	Dependent variable: $\ln(Size_{05}/Size_{01})$	
Independent variable	Complete multi-plant mergers (5)	Complete multi-plant mergers (6)
$\ln Size_{01}$	-0.1733***	-0.1733**
	(0.002)	(0.002)
$(\ln Size_{01})^2$	0.0294***	0.0294***
	(0.001)	(0.001)
$Age7$	-0.0428***	-0.0429**
	(0.003)	(0.003)
$Age10$	-0.0563***	-0.0563**
	(0.003)	(0.003)
HQ	-0.0410***	-0.0410**
	(0.003)	(0.003)
$Foreign$	0.0379***	0.0378***
	(0.007)	(0.007)
$Export$	-0.1005***	-0.0996**
	(0.029)	(0.029)
A	-0.0523*	0.0009
	(0.030)	(0.287)
$A \times \ln ASize$		0.0057
		(0.056)
$A \times \ln ISize$		-0.0185
		(0.033)
$A \times Age7$		0.0936
		(0.114)
$A \times Age10$		-0.0646
		(0.074)
$A \times HQ$		0.0996
		(0.086)
$A \times Export$		-0.1091
		(0.067)
$A \times Related$		0.0097
		(0.045)
Constant	0.3119***	0.3109***
	(0.028)	(0.028)
Industry dummies	Yes	Yes
Region dummies	Yes	Yes
Observations:	256,914	256,914
R-squared:	0.046	0.046

Notes: Acquired plants that are not part of a merger with at least four target plants are excluded from the sample in regressions (5) and (6). For further notes see Table 3.5.1.

other plants of multi-plant firms. We suppose that these headquarters usually conduct auxiliary tasks such as marketing or accounting. Hence, if the firm expands, these plants usually do not need to grow at a similar pace as, for example, the production units. Third, foreign-owned plants grow more rapidly than other plants. This suggests that these plants have access to (advanced) foreign technology and benefit from a knowledge transfer. Finally, the results provide evidence for adverse effects on employment growth in the course of mergers and acquisitions in export oriented firms and in firms where the acquirer and the target are in a related industry. An explanation for the first finding is the more competitive environment for firms in the export oriented industries and the

resulting pressure to realize more synergy effects. Whereas in related industries, it is not the competitive pressure, but instead synergy effects will rather be implemented by exploiting rationalization possibilities through overlapping (job) functions if similar businesses merge.

Future research might further explore our key finding, that the size differential between target and acquirer is a determinant for the growth of employment in the course of mergers and acquisitions. In particular, the analysis of financial data could provide additional support for our suggestion that financing constraints are an explanation for this result.

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3A Appendix to Chapter 3

Table 3A.1: Summary Statistics for Major Variables

Variable	Year	Nb. of Observations	Mean	Std. Dev.	Min.	Max.
$Size$	2001	262,032	8.80	39.91	0.27	5,333.06
$Size$	2005	262,032	8.78	40.42	0.28	5,825.10
A	n.a.	262,032	0.02	0.14	0.00	1.00
$Age4$	n.a.	262,032	0.18	0.38	0.00	1.00
$Age7$	n.a.	262,032	0.13	0.34	0.00	1.00
$Age10$	n.a.	262,032	0.69	0.46	0.00	1.00
HQ	2001	262,032	0.89	0.32	0.00	1.00
$Foreign$	2001	262,032	0.02	0.14	0.00	1.00
$Export$	2001	262,032	0.63	0.48	0.00	1.00
$ASize$	2001	2,850	4,057.18	9,574.91	0.27	29,666.63
$ISize$	2001	5,389	1,786.58	3,789.35	0.27	13,888.08
$CForeign$	n.a.	5,389	0.06	0.23	0.00	1.00
$Related$	n.a.	2,850	0.63	0.48	0.00	1.00

Notes: As in the regression analysis only surviving plants are considered. Figures for $ASize$, $ISize$, $CForeign$ and $Related$ are shown conditional on $A = 1$ as they are not available for plants that did not get acquired. Furthermore, for $ASize$ and $Related$ there are some missing values that reduce the number of observations.

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