International trade and the level of regulation

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23rd February 2003

Contents

1 Introduction **3**

2 International trade **8**
2.1 Introduction 8
2.2 International trade leads to a change of the optimal level of regulation 9
2.3 International trade leads to a deviation from the optimal level of regulation 15
2.4 Other marketfailures 20
2.5 Hypotheses 21

3 Alternative explanations **24**
3.1 Introduction 24
3.2 Special interest groups 24
3.3 Democracy versus Dictatorship 26
3.4 International politics 28
3.5 Hypotheses 29

4 Earlier empirical studies **30**
4.1 Introduction 30
4.2 Studies whereby trade explains the level of regulation 31
4.3 Studies whereby the level of regulation explains trade 33
4.4 Conclusions 35

5 Data and Method **37**
5.1 Introduction 37
5.2 The data 37
5.2.1 General structure 37
5.2.2 The dependent variable 39
5.2.3 The independent variables 41
5.2.4 Characteristics of the independent variables 47
5.3 Method 50
5.4 The theory and the data 53
5.4.1 Justifying the dependent variable 53

5.4.2 Transforming the hypotheses into general predictions . 54
5.4.3 Transforming the general predictions into specific predictions 60

6 Results 63
6.1 Introduction 63
6.2 Non-parametric analysis 63
6.3 Parametric analysis 70
6.4 Semi-parametric analysis 72
6.5 Conclusions 75

7 Conclusions and discussion 79
7.1 Conclusions 79
7.2 Discussion 81

A Treaties 84

B Countries 88

C Variables 93

D Method 99
D.1 Introduction 99
D.2 Probability distributions 99
D.3 Non-parametric analysis 103
D.4 Parametric analysis 109
D.5 The likelihood function 114
D.6 Unobserved heterogeneity 120
D.7 Semi-parametric analysis 124
D.8 Conclusion 127

E Model selection 129

F Robustness of parametric model 135

G Proportional hazard assumption 139

H Robustness of semi-parametric analysis 142

I Summary 144

Bibliography 150

Chapter 1

Introduction

Since the Second World War international trade has become an increasingly important part of the economy in most countries. This can be illustrated by the ever-increasing ratio of international trade to GDP, by the continued decline of trade barriers as a result of GATT and WTO agreements, or by the far reaching liberalisation of trade at regional levels. (Krugman and Obstfeld 2000, 236-39; Vogel 1995, 1) At the same time, the influence of the government on the economy has greatly increased. This influence has not been limited to the welfare state, but during the last thirty years many governments have become increasingly active in the fields of food quality, safety, the environment, etc. (Vogel 1995, 1; Vogel 1997, 98) Recently the question has been raised whether the importance of international trade has undermined the ability of countries to effectively enact regulation on these areas. This paper will try to shed light on the relation between international trade and the ability of countries to regulate. More specifically it will try to answer the following question:

> Does international trade influence the level of regulation?

The two important words in this question are international trade and the level of regulation. International trade signifies both the actual trade of goods and services across national borders and the possibility of international trade. The difference lies in the way one thinks that politicians make decisions. One can assume that politicians anticipate the reaction of all actors (who are or are not allowed to pariticipate in international trade) and than choose the level of regulation. In that case it is the possibility of international trade that influences the level of regulation and not international trade itself. However one can also assume that politicians work through trial and error. This means that they try a level of regulation and see how the actors react to it and then adjust the level accordingly. In that case, it is the international trade itself that influences the level of regulation. The results should be the same, except that there will be a delay before the optimal solution is found in the trial and error scenario. Real life decision making is probably best described by a combination of the two. So, generally I will not differentiate between these two connotations.

The second word in the question that needs to be discussed is the level of regulation. The level of regulation can refer to the amount of benefits the regulation brings to the benaficiaries or to the amount of costs the regulation imposes on the regulated. This paper will concentrate on the first meaning of the level of regulation, since this corresponds most closely with the way this word is used in the discussion on the 'race to the bottom'. The subject of this paper was inspired by this discussion, which is discussed in more detail below. Regulation itself means a rule or law that is enforced by the government. It will often be useful to restrict this meaning to rules or laws that intend to solve an externality. An externality is said to exist when the following two conditions are met: '(1) An activity by one agent causes a loss of welfare to another agent. (2) The los of welfare is uncompensated'. (Pearce and Turner 1990, 61) An externality is basically a resource that is owned by nobody and that everybody can use free of charge, for instance the clean water in a river. The problem is that by polluting the river one imposes a cost on others without having to compensate them. Consequently, each individual lacks the incentive to prevent pollution of the river and the river will become too polluted. Many problems can be viewed as an externality, for instance over-fishing, air pollution, and health and safety risks run by employees (when the responsibility for accidents has not been clearly defined).

The main question of this paper is inspired by the discussion on whether there are any theoretical or empirical grounds for the fear that international trade will lower the level of regulation. This fear is often revered to as a fear for a 'race to the bottom'. The following line of reasoning is behind this concept: Regulations are costly for the regulated. Companies will locate in the place where their production costs are lowest, and thus to the places with the least regulation. Since trade has become increasingly more liberalised, companies have become increasingly more mobile. An ever-larger share of production will move to tax havens, pollution havens, or more generally to regulation havens. All countries have to adapt their own level of regulation to the level of regulation of the least stringent country, in order to prevent the loss of production (and with that employment). However the process does not end when all countries have adjusted their level of regulation, because all countries have an incentive to lower their standards even further in order to (re)capture some of the production from other countries. This process will go on until the lowest possible level of regulation has been reached. (e.g. Genschel and Plümper 1997, 626; Hertz 2001, 52-53; Vogel 1995, 5; Wilson 1996, 393)

This line of reasoning is not as self-evident as it may seem. It focuses solely on the 'winning' and 'losing' of industries, while this is not really the issue. A country does not necesarily gains anything when it 'wins' an industry. A country wins from international trade because it allowes the country to specialize. This is true because 'international trade is really just a production technique, a way of producing importables indirectly by first producing exportables, then exchanging them.' (Krugman 1997, 115) The supporters of the race to the bottom theory are right that the introduction of new regulation may lead to the loss of an industry. However, this just means that it has become cheaper to 'produce' the goods from the lost industry by producing some other good and exchanging them for the goods from the lost industry. An industry moves away because the resources it uses can be used more effectively by another industry. So the interaction of increased regulation and international trade does not mean that there will be more unemployment, instead it allows a country to make the best use of its resources and its preferences for regulation. This does not mean that regulations bear no cost. Regulations that raise production costs will result in less production (in the short run the amount of resources are fixed, so if it takes more resources to produce one item as a result of increased regulations, fewer items can be produced), but international trade does not exacerbate this.

Those who fear a race to the bottom are however not completely wrong. International trade can, under quite plausible circumstances, lead politicians to choose a less than efficient level of regulation. Three such circumstances are distinguished in the theoretical section of this paper. The first circumstance happens when the regulated industry is non-competitive. In that case the industry will earn rents abroad. Lowering the level of regulation (i.e. subsidizing that industry) will enable that industry to grab a larger share of those rents. The second circumstance happens when shifting resources between industries is costly. I argued that the loss of an industry is not necessarily an extra cost of regulation because resources that where used in that industry (for instance workers) are now used more effectively in another industry. However, the relocation of resources between industries is generally not instantaneous and without cost. This may cause international trade to generate an extra (temporary) cost of regulation if the regulation brings about the loss of an industry. This may deter countries from raising the level of regulation. The third circumstance happens when a country is large enough to be able to influence world prices and this country imports the regulated good. In that case it can lower the price of its imports by lowering the level of regulation in the importing industry and thus increase supply of those goods. So, international trade does not have in itself a negative influence on the level of regulation, but some circumstances can cause international trade to have a negative impact. However, there are also two circumstances that can make international trade have a positive impact on the level of regulation. First, international trade can have a positive impact when there is an important trading partner with a higher level of regulation. Exporting to this high standard country will be difficult either because the citizens in that country demand high standard goods or because the firms in that country resent having to compete with low standard goods and demand a 'level playing field'. Higher levels of regulation may be a cheap way for exporting firms of signalling compliance with the higher standards of the importing country. Second, international trade can have a positive impact when the country is large enough to be able to influence world prices and it exports the regulated good. In that case it can raise the price of its exports by increasing the level of regulation in the exporting industry and thus reduce supply of those goods. In short, international trade can have a positive or a negative effect on the level of regulation depending on the circumstances.

In order to test this theory one needs to find a way of measuring and comparing levels of regulation. The level of regulation will in this study be measured by the time it takes to ratify a treaty. This measure can be justified in two ways. First, one can assume that fast ratification implies "a more intense preference for the provisions it contains" (Fredriksson and Gaston 2000, 347). Second, if we assume that there has been an exogenous upward trend in levels of regulation (due to changes in technology, knowledge or ideology), than international trade does not so much impact the level of regulation but the speed at which the regulation rises. Countries whose level of regulation rises fast will be fast ratifiers and countries whose regulation rises slowly will be slow ratifiers. The advantages of using this way of measuring regulation are that it is well suited for showing the dynamic aspects of the influence of international trade on regulation and that there is very little measurement error in the dependent variable. However, the validity of this measure of the level of regulation could be less obvious. The fact that a country has signed and ratified a treaty may not be an accurate representation of the level of regulation. One reason for this could be that treaties are often seen as not ambitious enough, so ratifying a treaty would be no more than "window dressing" and it would not mark a significant increase in the level of regulation. Another reason is that some counties will implement a treaty more conscientiously than others will. However it will be shown that countries generally take quite a long time to ratify a treaty. If ratifying were just a hollow act, than why would it take so long to ratify?

Using the time till ratification as a measure of the level of regulation has been done before by Per Fredriksson and Noel Gaston (2000) and Eric Neumayer (2002). However this paper will improve upon these studies in two ways. First, it will allow international trade to have different influences on the level of regulation under different circumstances. Previous studies have just looked at the impact of international trade regardless of the circumstances. This way one measures a net effect, and this net effect is likely to be small since international trade can have both positive and negative effects. This could explain why these studies have not found a large impact of international trade. Second, this study will cover multiple treaties which will be analysed simultaneously. This way the results will be less influenced by peculiarities of specific treaties.

This paper will consist of a theoretical and an empirical part. The theoretical part starts with the next chapter in which the theory behind the influence of international trade on the level of regulation is presented. This will be followed by chapter 3, which will discuss the theory behind some other factors that might explain differences in the level of regulation. This is done because some of the statistical techniques require that all factors that might cause such differences are included in the model. The hypotheses, which will be tested in the empirical part of this paper, will be based on these two chapters. The empirical part of this study begins with chapter 4, which discusses the results of previous empirical studies on this question. The data that is used to test the hypotheses and the method used in the analysis will be presented in chapter 5 and the results of the analysis will be presented in chapter 6. This study will end with conclusions and discussions, in which the results of the analysis will be confronted with the question asked in this introduction and which will reflect upon the strong and the weak points of this study.

Chapter 2

International trade

2.1 Introduction

This chapter will investigate whether there are theoretical reasons to assume that international trade influences the level of regulation in a country. It will be assumed that regulations only deal with externalities, i.e. costs caused by the activity of one agent on another agent for which the other agent is not compensated. For instance, an externality occurs when a company can dump waste at will and for free in a river, even if people down stream are effected by it. Seen from perspective of the producer, an externality could be considered as a production factor, which he gets for free. A producer can use the river to dump his waste in. He thus gets the 'waste disposal services' of the river for free. Seen from the perspective of the 'victim' the externality is a consumption good 'stolen' by the producer. People downstream are confronted with a polluted river. The ability to enjoy a clean river has been 'stolen' from them by the producer. Regulation intends to prevent the 'stealing' either by banning it or by making sure that the right price is paid for it.

International trade can influence the level of regulation in two ways: First, the chosen level of regulation approaches the optimal level of regulation, but international trade changes the optimal level of regulation. The optimal level of regulation is determined by balancing the costs of regulation with the benefits. The cost of regulation is reduced production. International trade changes the price of the goods that are produced, and thus also the cost of regulation. If the world price is higher than the domestic price, than the cost of regulation will rise when international trade is allowed, since the goods that have to be sacrificed become more valuable. Similarly, if the world price is below the domestic price, than the cost of regulation will drop when international trade is allowed, since the goods that have to be sacrificed become less valuable. So international trade increases the optimal level of regulation when the country imports and decreases the level of regulation when the country exports.

Second, international trade can lead governments to choose levels of regulation that deviate from the optimal level of regulation. This could be the case in four circumstances:

1. The country is so large that it can influence world prices. In this case the country can decrease the price of its imports by lowering its standards and increase the price of its exports by raising its standards.

2. The regulated industry is non-competitive. In this case companies will often receive subsidies and too low levels of regulation are a form of subsidy.

3. There are important trading partners, which have higher levels of regulation. Exporters may now benefit from higher levels of regulation since this would make it easier for them to signal compliance with the regulations of the high standard importing countries.

4. The relocating of resources between industries is costly. Losing an industry because of high levels of regulation is not a bad thing, as long as the resources used in the lost industry can easily be reused by another industry. However this is often not the case. The loss of an industry can thus cause short term costs and thus leads to lower levels of regulation.

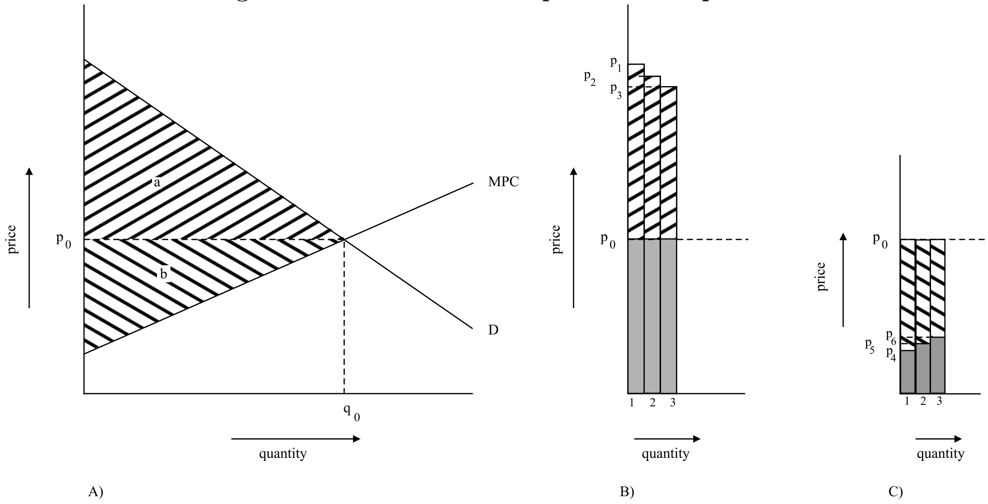
This chapter starts with discussing the impact of international trade on the optimal level of regulation. In this paragraph the concepts of externality and optimal level of regulation will also be discussed in more detail. After that the four circumstance which may lead to deviations from the optimal level of regulation will be discussed. This chapter ends with a list of hypotheses that can be derived from these theories.

2.2 International trade leads to a change of the optimal level of regulation

Externalities and the optimal level of regulation

International trade can influence the level of regulation if it changes the optimal level of regulation. The optimal level of regulation must first be determined, before this type of interaction between international trade and the level of regulation can be dealt with. As was already mentioned, regulations are assumed to deal with an externality. An externality exists when two conditions are met: An activity by one agent causes a loss of welfare to another agent and this loss of welfare is uncompensated. (Pearce and

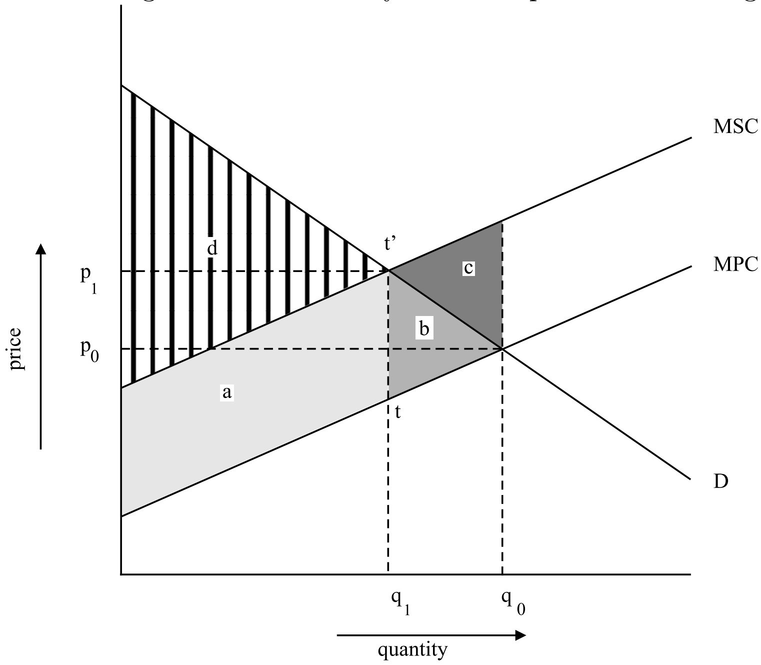
Figure 2.1: consumer and producer surplus



Turner 1990, 61) The problem the government faces is to determine how to deal with this situation. For instance, the outright banning of the activity will in many cases not be the optimal solution since it would not only make the externality disappear but also the benefits that that activity may have. In order to illustrate this we will use extensions of graph 2.1.

Graph 2.1 demonstrates two things: how the market determines the amount produced and the price, and how to conceptualise the welfare effects of changes in the market. Panel A represents the market of a good. MPC represents the marginal private costs to the producer, i.e. the cost the producer has to pay in order to be able to produce one extra unit of the good. D represents the demand for the good. That is, the price people are willing to pay for one extra unit of the good. Panels B and C are blow-ups of the first part of the demand curve (D-curve) and the marginal private cost curve (MPC-curve) respectively. A producer who maximises his profit will produce until its marginal cost equals his marginal returns. The producer could make one unit of the product for p_4 and at least one consumer would be willing to pay p_1 for this good, so that good can be sold at a profit. The producer could increase its profit by producing a second good. Making it would cost him p_5, but there are consumers that are willing to pay p_2 for it. This continues until q_0 is produced and the cost of producing the last unit equals the price the consumers are willing to pay for it. If the producer would produce an extra unit than that would cost him more than consumers would be willing to pay for it, and the producer would make a loss on this last unit. So on this market q_0 will be produced and sold against p_0. One can evaluate the welfare effects of changes in the market by looking at the consumer surplus (area a) and the producer surplus (area b). The consumer surplus measures the amount a consumer gains from a purchase by the dif-

Figure 2.2: externality and the optimal level of regulation



ference between the price he actually pays and the price he would have been willing to pay. For example the first person was willing to pay p_1 for this good but got it for p_0, so he gained p_1-p_0. This is the same as the upward striped area in the first bar in panel B. The second person was willing to pay p_2 and got it for p_0, which means that he gains the upward striped area in the second bar and so on. The consumer surplus is the sum of all these areas. So, in general the consumer surplus is measured by the area bounded above by the demand curve and below by the market price. This is area a in panel A. The producer surplus is a analogous concept. It measures how much a producer gains from selling a product by the difference between the price at which he was prepared to sell it and the price he receives for it. This is the downward striped surface of the first bar for the first unit, for the second unit it is the surface of the downward striped area in the second bar and so on. So, generally the producer surplus is measured by the area bounded above by the market price and below by the MPC-curve. This is area *b* in panel A. The sum of these two surfaces is the total welfare created by producing and trading this good. Graph 1 can be extended to show the effect of an externality and to determine the optimal level of regulation. This is done in graph 2.2.

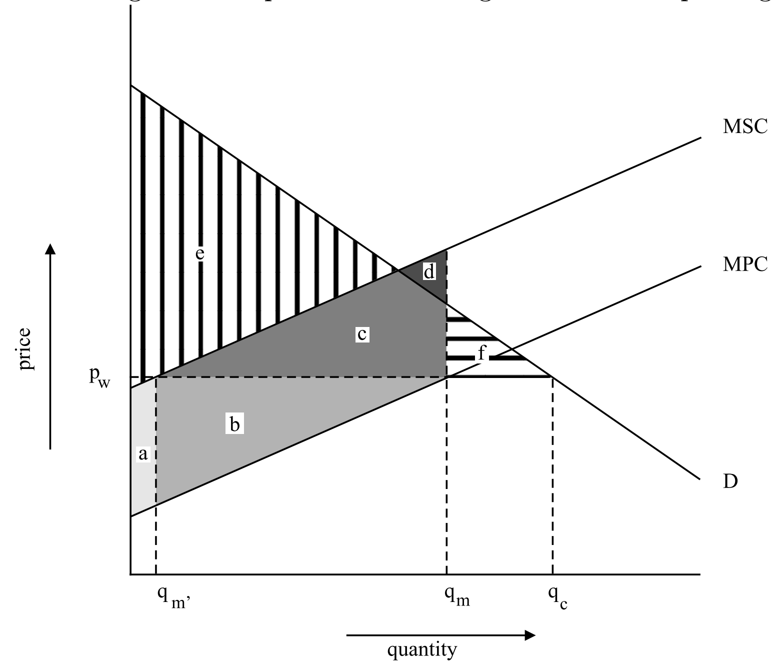
Remember that an externality exist when the producer can shift some of its costs to others. This means that the costs the producer faces are less than the costs the society as a whole faces. The costs faced by society are captured by the Marginal Social Costs line, which is denoted as MSC in graph 2.2. If no policy is enacted than q_0 will still be produced and sold for p_0. However, by neglecting the social costs of production a producer will produce too much and the consumers consume too much. This can be shown by looking at the net social welfare (the consumer surplus plus the producer surplus minus the external costs). The consumer surplus plus the producer surplus is still the area $a + b + d$, which is the same as area $a + b$ in graph 2.1. But society is also faced with the cost of the externality of $a + b + c$. So, the welfare generated by producing and selling the good is now $d - c$. The social welfare can be maximised when q_1 is produced and sold for p_1. If even less is produced than this will cut into the benefits represented by area d and if more is produced than some section of the costs of area c will remain. The optimal level of regulation makes the producer produces the amount as if he had to compensate the victims of the externality. There are several ways in which a government can achieve this optimal situation. One way of regulating externalities is to set a maximum to the amount of externality that can be used. This is the most frequently used way of regulating an externality. (Pearce and Turner 1990, 102) In this case a government achieves the optimum solution when it sets that maximum at a. Alternatively, the government could levy a tax of the size tt' for every good produced. The marginal cost will than be the marginal private costs plus the tax. The line MPC will thus move tt' upwards and will become equal to MSC[1]. Taxes used to control the use of externalities are often referred to as pigovian or eco-taxes. These two ways of regulating will achieve the same result but the tax is used less often than the quotum.

Changes in the optimal level of regulation caused by international trade

How international trade can change the optimal level of regulation can now be investigated. This is done using an extension of figure 2.2. We start with the small country case. A country is small when changes in production do not influence world prices. That means that the country can take the world price as given. The world price will thus be represented by a horizontal line. The country must decide whether it will allow international trade or not. The producers and consumers will face the prices determined on the world maket if a country allows international trade and they will face the prices determined on the domestic market when international trade is not allowed. The country will export the good if the world price is higher than the domestic price and it will import the good when the world price is below

[1] This is true because in figure 2.2 it is implicitly assumes that the marginal external costs do not change with the amount of q produced. As a result MSC runs parallel to MPC. However the conclusions will still hold if this assumption is dropped. It will however make the graph messier, since an extra line has to be drawn.

Figure 2.3: optimal level of regulation in a importing country



the domestic price. An importing country is represented in figure 2.3 and an exporting country will be represented by figure 2.4.

Graph 2.3 shows that the country is importing the good because at the world price (p_w) the people will demand q_c goods and domestic firms will produce q_m if there is no regulation. Consequently the country will import $q_c - q_m$. The consumer surplus plus the producer surplus will be $a + b + c + e + f$ and the costs of the externality will be $a + b + c + d$, so the social welfare created by the production and trade of the good will be $e + f - d$. The social welfare can be maximised by reducing production to q_m'. The social welfare will now be $e + c + f$. If the externality is regulated by setting a maximum to the use of the externality than the regulation will set that maximum at a. This maximum is thus stricter than the maximum set in a autarkic economy, represented in graph 2.2.[2]

[2]What happens to the level of regulation when the externality is regulated by a pigovian tax is more complex. Figure 2.3 indicates that this tax remains unchanged, but this is only true because in this figure it is assumed that the external costs of every extra unit does not change with the amount of goods produced. This is the case in figure 2.3, because the marginal private cost line runs parallel to the marginal social cost line. It could however very well be the case that the external cost of producing an extra unit increases with the total production. In that case the optimal level of regulation would fall as a result of international trade. However declining marginal external costs or more complex shapes of the marginal external costs are also possible. An example of the latter would be marginal external costs of polluting a river that first rise and then drop because, because increasing pollution of a river cause increasing numbers of fish to die, but extra pollution will have no

Figure 2.4: optimal level of regulation in a exporting country

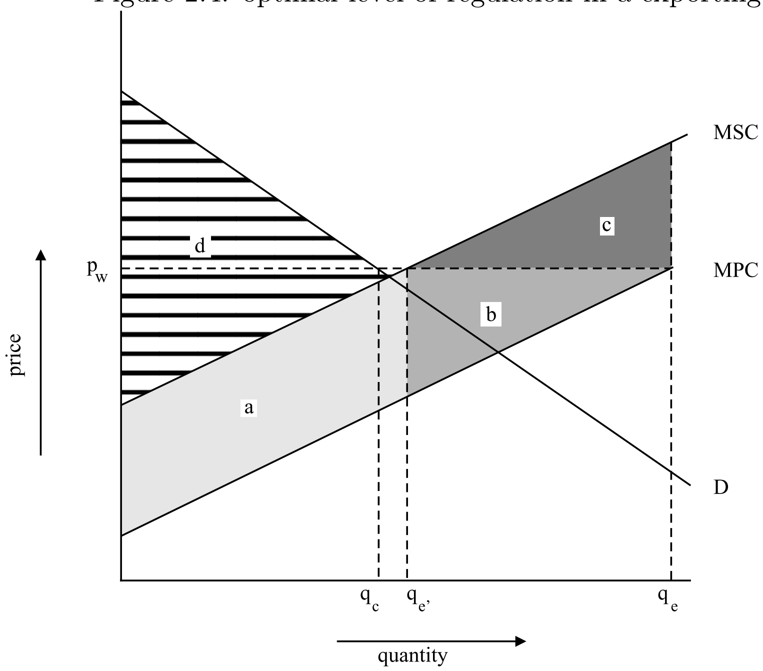


Figure 2.4 applies the same analysis to a small exporting country. In absence of regulation q_c will be demanded and q_e will be produced, which means that $q_e - q_c$ will be exported. The consumer surplus plus the producer surplus will be $a + b + d$, and the cost of the externality will be $a + b + c$, which means that the social welfare created by the production and trade of the good is $d - c$. The optimal level of regulation will reduce the production to $q_{c'}$. If this is done by setting a maximum to the amount of externality used than this maximum has to be set at a, which is larger than this area in the case without international trade represented in graph 2.2. So, international trade reduces the level of regulation in the case of an exporting industry.

In short, when regulation is enacted as a maximum amount of externality use, than the optimal level of regulation will increase when the country is an importing country and decrease when the country is an exporting country. The reason for this is that the optimal level of regulation is determined by balancing the costs and benefits of regulation and the costs of regulation stems from reduced production. International trade reduces the price of the goods when the country is importing and raises them when it exports. International trade thus makes regulation cheaper when the country imports

effect ones every fish in the river is dead. In short, it is very difficult to make a reasonable assumption on these marginal costs. This makes making predictions on what happens to the level of the pigovian tax very difficult since this requires knowledge on these marginal external costs.

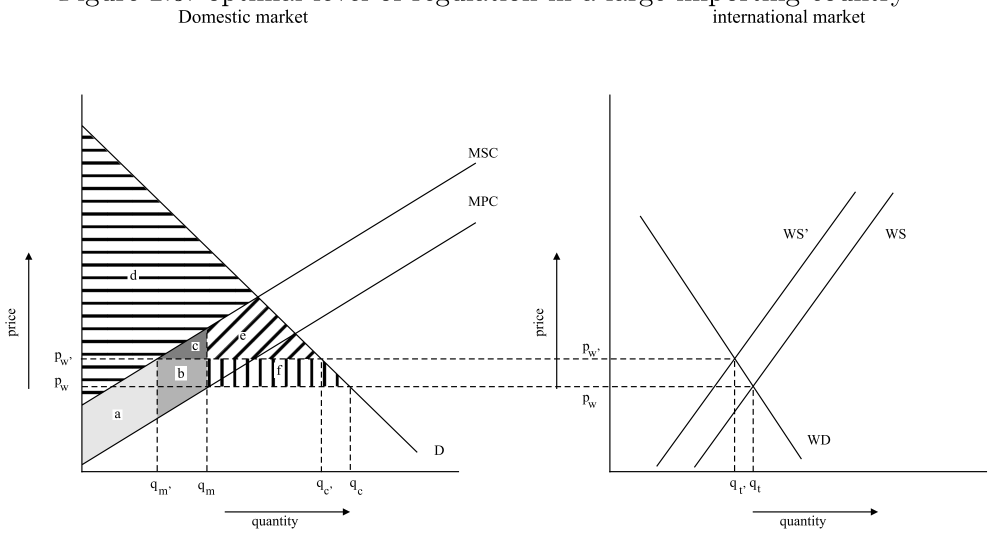
and more expensive when it exports.

2.3 International trade leads to a deviation from the optimal level of regulation

The country is so large that it can influence world prices.

The first circumstance under which international trade can lead to a deviation from the optimal level of regulation occurs when a country is large enough to influence world prices. Small countries can take the world price as given, large countries have to take the impact of their actions on the world price into account. If a large country regulates than the consequent drop in production will be large enough to make the worldprice of that good rise. So, a large country can make its exports more expensive by increasing the level of regulation above the optimal level. Similarly, a large country can make its imports cheaper by lowering its level of regulation below the optimal level. This can be illustrated with the help of figure 2.5. It shows that q_c will be consumed and q_m will be produced when the externality is not regulated. The consumer surplus plus the producer surplus is $a + b + c + d + e + f$ and the cost of the externality is $a + b + c$, so the social welfare generated by producing and trading the good is $d + e + f$. Enacting the optimal level of regulation will have two effects. First, it will reduce the amount of externality used. Second, it will reduce production and this leads to a shift of the world supply curve on the world market from WS to WS'. This in turn leads to a price increase from p_w to $p_{w'}$. The social welfare will now be $d + c + e$. This means that introducing the regulation leads to an increase in welfare of c due to decreased use of the externality and a decrease in welfare of f, due to the increase in the price of imports. In order to maximise the welfare of its citizens a large country must thus chose a level of regulation that will be lower than the optimal level. Following the same line of reasoning leads to the conclusion that large exporting countries will have levels of regulation above the optimal level because of the benefit from higher prices for their exports. Note that the effect of the terms of trade diminishes the difference between exporting and importing countries that existed for small countries. Thus large countries are more similar to each other than small countries. In an ideal world this would be tested by first testing the differential impact of imports and exports on the level of regulation (i.e. the impact of international trade through its impact on the optimal level of regulation) and then test whether this difference diminishes or even disappears for large countries. An alternative approach is possible if one assumes that many treaties have harmonising tendencies. Since large countries will be more similar to each other, one can predict that large countries will more inclined to ratify a treaty than small countries.

Figure 2.5: optimal level of regulation in a large importing country

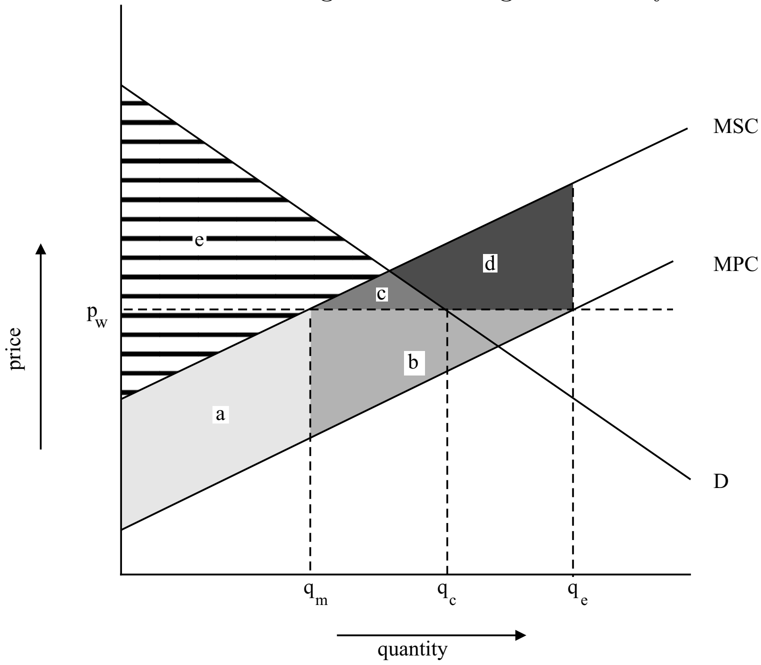


Relocating resources between industries is costly

A claim made by those fearing a race to the bottom is that governments are afraid to raise the level of regulation because an industry might relocate to another country. (e.g. Hertz 2001, 52) However there is under ideal circumstances nothing to fear about a relocation of an industry. Figure 2.6 illustrates this. When the use of the externality is not regulated than q_e will be produced, q_c will be consumed and $q_e - q_c$ will be exported. The consumer surplus plus the producer surplus is $a + b + c + e$, and the amount of externality used will be $a + b + c + d$. The social welfare generated by producing and trading the good will thus be $e - d$. When the externality is regulated the production will drop from q_e to q_m which means that $q_c - q_m$ will be imported. The social welfare increases as a result of the regulation to $e + c$, even though the country changed from an exporting to an importing country. The producers will of course dispute this conclusion, since they loose b when the externality is regulated by setting a maximum to the amount of externality they can use. But this loss is more than compensated by the gains the victims of the externality receive from reduced use of the externality ($b + c + d$).

Still, production is reduced more than would have happened when international trade was not possible. However, this just means that it is cheaper to use the resources previously used in the regulated industry in another industry. The exports are than used to pay for the imports of the regulated good. More units of the regulated good can be 'produced' through this indirect way than by producing those goods at home. Through trade every country can do the best they can given their resources and their preference for regulation. However, this line of reasoning implies frictionless markets.

Figure 2.6: losing an industry



This is often not the case. Workers need retraining in order to work in another industry and even than it may take a long time until all worker have found new jobs. This is a short run cost. However, if a region relied heavily on the leaving industry the cost can be significant. (Jaffe et al. 1995, 133) Due to this friction in relocating resources one can expect that a country is reluctant to raise its level of regulation if it leads to the loss of an industry. In the long run the benefit of international trade and the regulation remain.

The regulated industry is non-competitive

A second reason why losing an industry may be costly occurs when the industry is imperfectly competitive. Quite a number of models dealing with this situation have appeared (e.g. Barret 1994; Ulph 1996; Ulph 1997) which are extensions of the Brander and Spencer (1985) model. In these models it is assumed that the number of firms is so small that each firm earns a rent above normal profit and that the size of this rent can be influenced by the actions of one other firm, even in the presence of international trade. The model in this chapter is a two-stage game. In the first stage the governments select a level of regulation. In the second stage the companies select the levels of output that will maximise their profit, given the output of the other firms and the level of regulation. Figure 2.7 represents this last stage in a situation with two firms, one located in a country called Home and the other in a country called Foreign. These two firms sell their goods to a third set of countries and cannot relocate. The curve hr gives the profit maximising amount of production by the home firm given the amount of production by the foreign firm, if Home enacts the optimal level of regulation. Fr is the same curve for the firm located in Foreign. The quantities both companies produce will be the cournot-nash equilibrium *a*, whereby the home firm produces q_h and the foreign firm q_f. The governments know that this is the way that companies will behave. So in the first stage of the game the government can shift home's reaction curve outward to hr' by lowering the level of regulation. Lowering regulation reduces costs, thus increasing the profit maximising quantity given the quantity produced by the foreign company. The new equilibrium will be point *b*, whereby the home firm has gained at the expense of the foreign firm. A reduction in regulation can, by deterring production or investment in foreign countries, raise the rents received by domestic firms. If a country takes this effect into account, than regulation will be at a level below the efficient level. However, the efforts to shift rents from foreign to domestic firms are self-defeating, since the foreign government will act in the same way, as is illustrated in figure 2.8. If both governments lower their externality taxes than the equilibrium will not shift to point *b*, but to point *c*. The result will be an expanded industry output, reduced rents and increased use of the externality. It is important to note that this model is not very robust to changes in assumptions. For instance if trade policy instruments, like export subsidies, become available, or when the competition between firms can best be described by Bertrand competition (companies react by changing prices) instead of Cournot competition (companies react by changing output), than there will be no incentive for governments to stray from an efficient environmental policy. (Ulph 1997, 224-25) However many trade policy measures have become less available due to actions taken within organisations like the GATT, WTO and the EU, and Cournot competition is an appropriate model for at least some of the imperfectly competitive markets. As a result one can still predict that regulations dealing with non-competitive industries will be less strict than regulations dealing with competitive industries. Furthermore the level will be lower the more the countries are exporting or importing.

Figure 2.7: effect of lowering the level of regulation when foreign does not react

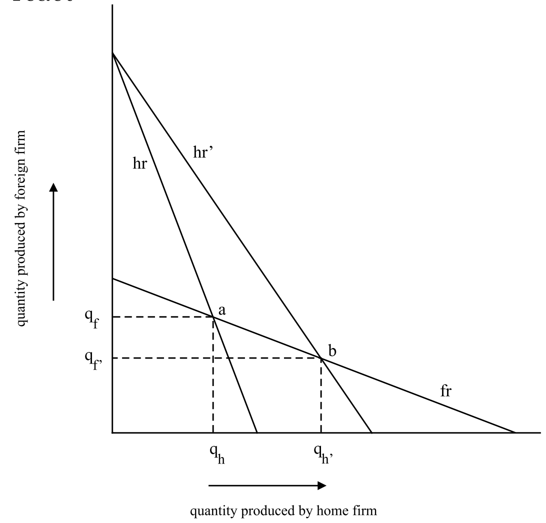
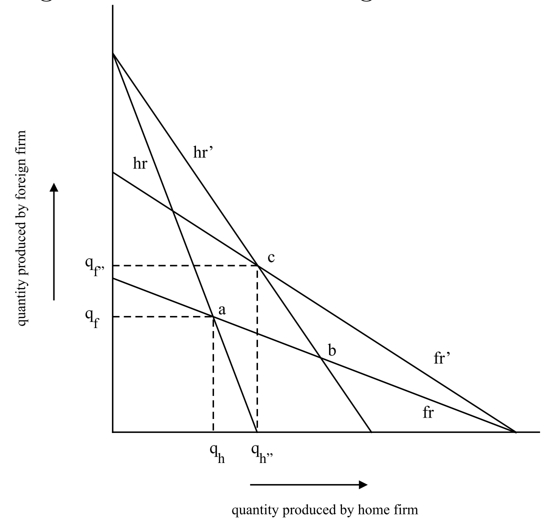


Figure 2.8: effect of lowering the level of regulation when foreign does react



This is not the only reason why non-competitive industries may be underregulated. If a firm posses resources that only a small number of other firms have and that a large number of countries want, and the firm wants resources which many countries can offer than the firm will be able to negotiate extra favourable terms. These rents may be in the form of subsidies, a lax tax regime, or lax regulation. Large multinational firm in an imperfectly competitive industry may have access to resources like technology, access to markets, capital and brand loyalty which could be very beneficial to a country. Especially developing countries have little access to these resources, and are thus particularly vulnerable to the influence of large (multinational) firms. However this influence exists only in imperfectly competitive industries, since in competitive industries a government will be able to find another firm willing to invest if one firm tries to extract a rent. (Kobrin 1987, 619-20) So companies in a non-competitive industry are likely to get subsidies either because that enables them to grab a larger share of the rents earned in the industry or because they have a strong bargaining position and these subsidies can be in the form of lower levels of regulation.

The presence of important trading partners which have a higher level of regulation

The hypothesis that non-competitive industries will be under-regulated holds when regulations are seen as costs and too low regulations as subsidies. However national regulation can also be a relatively cheap way of signalling to foreign consumers or authorities that a certain level of quality is achieved. (Vogel 1995; Genschel and Plümper 1997) This can be an important benefit when important trading partners enforce higher levels of regulation. In that case it may be difficult to export to a country if the importing country has higher levels of regulation than the exporting country, either because the people of the importing country prefer high standard goods or because the firms of the importing country resent having to compete with low standard goods and demand a 'level playing field'. If important trading partners prefer high levels of regulation, than countries that export to these countries, might gain from raising their level of regulation instead of dropping them.

2.4 Other marketfailures

A number of the contributions to the debate about the impact of international trade on domestic regulation concentrate on markets with multiple marketfailures. (e.g. Bhagwati and Srinivasan 1996; Brown et al. 1996; Oates and Schwab 1988 and see Wilson 1996 for a survey) These models intend to show that a race to the bottom does not always occur. They are basically 'second-best models'. Second-best models are based on the following general principle: In presence of multiple marketfailures there is no *a priori* way to judge what will be the effect of the correction of one marketfailure on efficiency or welfare. (Lipsey and Lancaster 1956, 12) The only way to make those judgements is to specifically model the marketfailures that will remain and the marketfailures that will be removed. For instance, the wages could for some exogenous reason be too high. Companies can for example pay efficiency wages in order to prevent employees from shirking, or a tax on labour can be levied which makes labour too expensive. This would lead to unemployment, which could be diminished if the economy receives an extra boost. Too low levels of regulation could be such a boost, but this result does not depend upon the presence of international trade. The need for a lower level of regulation will occur without trade and it is not exacerbated by the presence of international trade.

But marketfailures need not lower the level of regulation. Revenues generated from the correction of the externality can be used to correct one or more market failures. For example, the revenue generated by a pigovian tax on the externality (e.g. environment) can be used to subsidise labour. When discussing the effect of a pigovian tax it is generally assumed that the revenue raised by such a tax is returned to the people in a way that it does not influence production and consumption decisions. Suppose however that wages are too high as a result of a tax on labour, and the revenue of the tax on the externality is used to reduce this distorting tax on labour. In such cases one would expect a 'double dividend' from a tax on an externality: a more optimal use of the externality and a better functioning labour market. However if there are multiple goods produced with different amounts of the externality, the externality intensive goods could be substituted for the externality extensive goods. The tax base will thus be eroded. As a result the taxes raised by the pigovian tax will not be enough to completely replace the labour tax. (Bovenberg and Mooij 1994, 1087; Goulder 1994, 10) Basically, double dividend might reduce the problem of multiple marketfailures , but it will not solve it.

Michael Porter and Claas van der Linde (1995) point to another issue that might reduce the attractiveness of lowering standards. High levels of regulation may spur companies into developing new technologies. Too little regulation would make companies complacent, which would in the end result in a loss of competitiveness. In the long run high levels of regulation would promote Research and Development and the implementation of new innovations, which promotes economic growth and employment. They quote quite a number of case studies, which show that the gains as a result of technological advances may sometimes be larger than the direct costs of the regulation. However it is very difficult to determine whether or not these cases are the exception or the rule. Consequently there is stiff debate on whether these dynamic advantages outweigh the static costs of regulations. (e.g. Palmer et al. 1995)

2.5 Hypotheses

In short, international trade can influence the level of regulation by effecting the optimal level of regulation or by detracting from the optimal level of regulation. International trade influences the optimal level of regulation since international trade changes the price of the regulated good and thus the price of the regulation. The cost of regulation stem from the reduction in production it causes. This decreased production becomes more valuable when the price of the good rises, which would happen when the country export. The decreased production becomes less valuable when the price of the good drops, which happens when the country imports. International trade can under certain circumstances also detract from the optimal level of regulation. Four such circumstance where found.

1. *The country is large enough to effect world prices.* This way the country can lower the price of its imports by setting too low levels of regulation or increase the price of its exports by setting too high levels of regulation. This effect balances the effect of international trade through its impact on the optimal level of regulation. Consequently, large countries are more similar to each other than small countries. This means that large countries will be more likely to ratify a treaty since many treaties have homogenising characteristics.

2. *The regulation deals with a non-competitive industry.* In this case many companies will receive subsidies either because this will enable them to grab a larger share of the rents earned abroad. So, regulations dealing with non-competitive industries are expected to be more lax and they are expected to make the effect of international trade on the level of regulation more negative.

3. *There are important trading partners that have higher levels of regulation.* Those countries might be unwilling to allow lower standard goods access to their market. Higher levels of regulation might in such a case be a cheap way of signalling compliance with the higher standards of the importing country. So, international trade is expected to have a more positive effect on the level of regulation when there are important trading partners that have higher levels of regulation.

4. *Transferring resources between industries is costly.* Regulation may lead to the loss of the regulated industry. This is not a problem as long as the resources that where used in that industry can easily be transferred to another industry. If this is not the case than this could lead to a more negative impact of international trade on the level of regulation.

The effect of other marketfailures was also investigated. When these marketfailures require a boost to the economy than lower levels of regulation may be the result but this effect is unrelated to international trade. However, there are two reasons why the effect of other marketfailures on the level of regulation may not be that strong. First, if the externality is regulated through a pigovian tax, than the revenue generated by that tax could be used to provide a boost to the economy. Though, it is unlikely that the revenue of the pigovian tax alone will be enough to provide the necessary boost, it will at least help a bit and it makes lowering the level of regulation less attractive. However, the actual replacement of taxes on labour by taxes on for instance use of the environment has not taken place on any meaningful scale, so the double dividend argument will not play a significant role. Second, stringent levels of regulation may spur firms to innovate more. This way high levels of regulation may lead, in the long run, to a stronger industry. However, this effect works in the long run, and the need to provide a boost to the economy is generally a short term issue. So, we can expect that marketfailures will lower the level of regulation, but that this generally does not work through international trade.

Chapter 3

Alternative explanations

3.1 Introduction

International trade is unlikely to be the only explanation for differences in the level of regulation. The simplest example is that the preferences for a level of regulation are likely to differ due to differences in wealth. Citizens in a wealthy country are likely to demand beter environmental and labour standards and are able to pay more for them. Three additional alternative explanations will be put forward in this chapter. Paragraph 3.2 will deal with special interest groups. It will discuss why they would be influential and which groups will be able to organize a successful lobby. Paragraph 3.3 will deal with the impact of the level of democracy. Dictators will be seen as 'stationary bandits' (Olson 2000, 122) who have a monopoly on 'robbing' people living in their territory. They will have an incentive to provide a certain level of public goods, including regulation, if this increases production (and thus maximize the value of the loot they can extract from the population). Democratic leaders will be assumed to be only interested in staying into power and they can only do so by appealing to a majority of the population. Paragraph 3.4 will deal with international politics.

3.2 Special interest groups

Why would special interest groups exist if the democracy works perfectly and the citizens punishes every politician who does not act in their interests? If the favoured action is in the interest of the citizens then it will be implemented anyhow and if it is not, than it will not be implemented irrespective of how much lobbying is done. The problem is that individual citizens do not have the incentives to gather the necessary information on the people they elect. It is in their interest that the right person is chosen, but in order to select such a person they have to spend time, money and effort. However whether or not the right man will be chosen will probably not depend on how much one individual has invested to find out who the right person is. If all other citizens have not informed themselves, than the right person will not be elected and if all other citizens have informed themselves, than the right person would be elected anyhow. Both outcomes are independent of whether one individual has taken the time and effort to select the right man, so it is in his interest not to make that contribution. Putting it differently, selecting the right man is a public good: An individual will get the benefits of having the right man in office irrespective of whether he has positively contributed to the making of this decision or not. It is thus rational for an individual to remain ignorant and this leaves room for special interest groups to influence politics. This can be done by influencing the outcome of elections by providing free information/propaganda to the citizens or by providing this free information/propaganda to imperfectly informed chosen representatives or government officials or by (legally or illegally) buying influence with chosen representatives or government officials.

However, this raises the same question again. If individuals can not be persuaded to take the effort to inform themselves, why would they spend time, money and effort to support a lobbying group? The results of a lobbying group are just as much a public good (or bad) as the results from an election. However Mancur Olson (1971) has described certain circumstances under which a collective good may be provided, and these circumstances are more likely to exist for the actions of special interest groups than for elections. The first circumstance occurs when the group that benefits from the collective good is so small that at least one member will gain so much from the collective good that he will have a positive net result even when he pays the collective good all by himself. This large individual will however provide a sub-optimal level of the collective good, since he will see only the share of the benefit that accrues to him as benefit and ignore the benefit to other members of the group. Olson calls such a group a privileged group. The second circumstance occurs when the group is larger than the privileged group but not that large that every individual's contribution to a collective good would be unnoticeably small. In this situation it is rational for all individuals to react to the actions of other members of the group and to take these reactions in account. In such situations co-operation is a possibility but not guaranteed. A group of this size is called an intermediate group. Groups that are larger than intermediate groups, for instance the group of citizens when they have to decide whether or not to inform themselves before voting, can only provide a collective good when a separate and selective incentive stimulates rational individuals in a group oriented way. (Olson 1971, 51) Many labour unions for instance became large because they offered insurance.

What is important about all this, is that small groups will have an advantage in influencing governments. Furthermore the 'net influence' of all special interest groups together will not be equal to the interests of all citizens together. In other words the distorting influences of all special interest groups do not cancel each other out because many large groups will not be represented by an interest group. (Olson 1982, 37) For instance, the entire business community is less likely to be able to start an effective lobby than a specific industry. That means that a regulation that targets one specific industry will encounter much stiffer opposition than a regulation that targets the entire business community. The reason for this is that a specific industry is much more likely to be a privileged or intermediate group than the entire business community.(Olson 1971, 145-46)

3.3 Democracy versus Dictatorship

An important and visual variable on which political systems of countries differ is the level of democracy. This paragraph will investigate whether there is any theoretical reason to believe that this variable will influence the level of regulation in a country. In order to avoid to give democracy an unfair advantage it will be assumed that both the democratically elected leader and the dictator are equally self-interested. Two approaches will be used here. The first focuses on the differences in the incentives facing those in power in democratic and dictatorial regimes. Democratic leaders are supposed to want to remain in power, and their actions are intended to ensure that they will receive a majority in the next election. Dictators on the other hand are supposed to try to maximise the amount of goods and services they can extract from their country. This approach assumes that leaders are willing to spend an 'optimal' amount of time and resources to reach to their goals.

The second approach relaxes this assumption by focussing on the differential willingness of democratic and dictatorial regimes to deal with malfunctioning parts of society. The basic idea is that those in power value their free time and do not want to improve things unless spurred on by those who are negatively effected. In a democracy the effected citizens can spur their government into action by withdrawing their support for this government by voting for another party at the next election (exit) or directly approach the government with their grievance by demonstration, petition, etc. (voice). Both exit and voice are repressed in a dictatorship. The first approach is based on a paper by Mancur Olson (2000) while the second on a book by Albert Hirschman (1972).

The first approach sees a dictator as a bandit who maximised his loot by monopolising theft in his territory (Olson 2000, 122). In a world of uncoordinated competitive theft there is little incentive to produce or accumulate anything that may be stolen. As a result there is little that can be stolen. However if the stationary bandit believes his monopoly will hold for an indeterminate long period, than he can credibly guarantee his victims that they can keep a part of their output and thus raise production. The dictator also has an incentive to provide production enhancing public goods, since the dictator will receive a significant part of the production increase. A dictator will provide basic sanitation to a city when his share of the resulting increased production is larger than the cost of providing this service. Regulations, on the other hand, have benefits that are less easily stolen, but he does get a disproportionate large share of the production decrease that results from increased regulation (Congleton 1992, 417). So a dictator is less likely to enact regulation, especialy since he can generaly shift the cost of an externality away from him. The democratically elected leader on the other hand will have to keep the support of the majority. This does not necessarily lead to efficient outcomes, since the leader can just redistribute wealth from the minority to the majority. However it is less likely that the effects of externality use can be shifted from the majority to the minority than that the effects can be shifted from the dictator to the rest of the population. Furthermore the normal citizens that make up the majority will generaly get a smaller part from the production decrease that result from the regulation than the dictator. As a result, the level of regulation will on average be higher in a democracy than in a dictatorship.

This same conclusion can be derived when one looks at the willingness of the leaders to deal with sub-optimalities. Recuperation mechanisms should give the powerholders information about what is wrong and give them incentives to act on this information. Hirschman (1972) distinguishes the recuperation mechanisms exit and voice. In the case of a democracy exit represents withdrawing ones support in an election and voice represents actions like petitions and demonstrations. The availability of both mechanisms at the same time is not necessarily a good thing. The presence of exit as a feasible strategy might undermine the willingness to use voice, since exit will generally be cheaper to use than voice (Hirschman 1972, 45). Compare for instance the effort needed to vote for a different party with that of organising a demonstration. However, the possibility of threatening to exit may increase the effectiveness of voice. (Hirschman 1972, 82-86) The net effect will be determined by the fine details of the situation, but it is safe to assume that in many cases there will be at least some form of recuperation mechanism present in a democracy. Both mechanisms are however (by definition) suppressed in a dictatorship. The ability to recuperate from lapses of efficiency depends on the willingness of the dictator to listen to criticism. This is not a quality that comes natural to most dictators. As a result it is more likely that a democracy can deal more effectively with imperfections like externalities than a dictatorship can.

However, the prediction that democracies have higher levels of regulation than dictators does not mean that the level of regulation is predicted to rise continously with the level of democracy. Intermediate levels of democracy do not have automatically intermediate levels of regulation. Both dictatorships and democracies are predicted to have incentives to enact a certain level of regulation, and this level is higher for democracies than for dictatorships. The institutions of a semi-democracy can be structured in such a way that the rulers miss both types of incentives, or have incentives to enact regulations of an intermediate level.

3.4 International politics

An important characteristic of international politics is the absence of a world government. A world government could facilitate welfare enhancing measures (from the perspective of all the citizens in the world) by two distinct methods: it can enforce promises made by individual countries and it can force all involved to pay their share. Several situations have already been discussed in this paper whereby the absence of either method causes inefficient levels of regulation. For instance, paragraph 2.3 on the effect of international trade in an imperfectly competitive industry on regulation models a situation in which uncoordinated action of individual countries leads to inefficient outcomes. Here the absence of the first method is the problem. Both countries would benefit if they could credibly promise not to reduce their standards below efficient levels. A world government could help in such a situation because international co-operation is beneficial to all countries, but all countries individually have an incentive not to co-operate. This paragraph deals with the circumstances under which self-centred rational countries might still co-operate.

The above case is a prisoner dilemma. If other countries regulate the externality, than our country will be better off by not regulating the externality. The reason for this is that this will give its own non-competitive industry an advantage. If the other countries do not regulate, than it will again be best off not to regulate. The reason for this is that it will prevent loss of production from non-competitive industries to other countries with low regulation. However all countries would prefer the situation in which all countries regulate at the efficient level. However, under-regulation will be the dominant strategy. A prisoner dilemma also occurs when the effects of an externality cross a border. In this case the country gets only a limited part of the benefits from its own efforts and it gets a part of the benefits from the efforts of other countries for free. So when the other countries regulate his best choice is not to regulate since he will still benefit from the regulation of others. When the other countries do not regulate his best choice is again to under-regulate, since he will ignore the benefits that acrue to the other countries.[1]

[1]Not all situations can be described as prisoners' dilemmas (Axelrod and Keohane 1985, 229-30). This paragraph will however concentrate on the prisoners' dilemma since

A prisoners' dilemma taken in isolation will lead to an equilibrium whereby all countries under-regulate, as was already mentioned. There is however one characteristic of the real world that differs from the isolated prisoner's dilemma and which may foster co-operation. Countries deal repeatedly with one another. Co-operation can be an equilibrium in a repeated prisoners' dilemma if the actors care enough about their future (Axelrod 1984). The intuition behind this result is that the other actors can punish non-co-operation in a repeated game by also not co-operating in the future. This would suggest that those countries that deal a lot with each other (for example because they share a border) would be more likely to co-operate with each other. Furthermore countries that have already invested a lot in generating trust with each other by having co-operated in the past, will be more likely to co-operate. Additionaly, local groups of countries consist (by definition) of less countries than the entire world and paragraph 3.2 showed that small groups have an advantage in ensuring co-operation. So local groups of countries are more likely to co-operate because they repeatedly interact with one another and because such a group will consist of a relatively small number of countries.

3.5 Hypotheses

The conclusions of this chapter can be summarised in four hypotheses. The first hypothesis is that richer countries will have higher levels of regulation than poorer countries. The reason for this is that the demand for regulation is likely to rise with income. The second hypothesis states that regulations dealing with individual industries will be less strict than regulations dealing with the entire 'business community'. The reason for this is that individual industries are more likely to be able to organise an effective lobby due to the difference in size of these two groups. The third hypothesis states that democracies will have higher levels of regulation than dictatorships, since dictators pay a large share of the costs of the regulation and are unlikely to be able to appropriate a large share of the benefits. Furthermore, recuperation mechanisms like exit or voice are more likely to work in a democracy than in a dictatorship. The fourth hypothesis results from the observations that most countries have a limited number of countries with which it is likely to have to deal with in the future and that small groups of countries are more likely to enforce co-operation than large groups of countries. Consequently, local co-operation to raise the level of regulation is more likely to succeed than co-operation on a larger scale.

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it is a quite common and difficult to solve problem.

Chapter 4

Earlier empirical studies

4.1 Introduction

The main question in this paper is whether international trade influences political decision-making about the level of regulation. In chapter 2 several theoretical answers to this question where discussed. Chapter 3 reviewed theories about several other factors that might influence the level of regulation. However, empirical research has proven to be a lot more difficult, since the level of regulation is difficult to measure in such a way that is comparable between states. (Jaffe et al. 1995, 158) Still, some empirical work has been done in this field. Two types of studies are of interest here. The first type consists of four studies that try to explain the level of regulation in a country. Three of these studies use data on signing or ratification of treaties as a measure of the strength of regulation, and two of these include international trade as an explanatory variable. One study uses an index based upon reports prepared for the United Nations Conference on Trade and Development as a measure of the strength of regulation. This study however does not include international trade as an explanatory variable. The second type of study looks at whether increases in the levels of environmental regulation have eroded the competitiveness of countries. These studies can give clues on two central issues. First, I hypothesised that international trade could have an effect when relocating resources between industries is costly. This effect only happens when there is a real chance that increased regulation leads to a loss of an industry and thus to a need to relocate resources. So, international trade is not likely to work through the costs of relocating resources between industries if no effect is found of regulation on the competitiveness. Second, the effect of international trade through the non-competitiveness of regulated industry assume that low levels of regulations could be used as a form of subsidy. If low levels of regulation are indeed a form of subsidy than they would increase the competitiveness. So, a positive effect of low levels of regulation on the competitiveness is a necessary (but not sufficient) condition for the hypothesis that international trade could work through the costs of relocating resources and it is an indication that low levels of regulation can indeed be used as a form of subsidy.

4.2 Studies whereby trade explains the level of regulation

The first study discussed in this paragraph is an article by Roger D. Congleton (1992) whose aim is to test the hypothesis that democracies have higher levels of regulation then non-democracies. The theory on which he bases his hypothesis is largely similar to the one presented in paragraph 3.3. In order to test this hypothesis he assumes that countries that have signed the Convention for the Protection of the Ozone Layer and the Protocol on Substances that Deplete the Ozone Layer by 1989 have higher levels of regulation than those countries that have not done so. He analyses the data on these treaties separately. So the dependent variable is a variable indicating whether the country has ratified the treaty under investigation. The explanatory variables used are variables denoting whether a country is democratic, whether the country is socialist, the GNP per capita, different measures of the resources available to a country (the oil reserves, the coal reserves, the gas reserves and the land area of the country), and the population. In the different logit regressions he finds that being a democracy increases the probability of having signed by 1989, indicating that democracies indeed have higher levels of regulation then non democracies. Being a capitalist country or not did not have a significant effect, GNP per capita had a mildly significant (10%) positive effect on the probability of signing the treaty. In most of the cases the resource variables had no effect. The same is true for the variable denoting the population of the country. Two points have to be made about this study. The first point is that the study uses data on whether a country has signed a treaty and not whether the country has ratified the treaty. Data on whether a country has ratified a treaty would have been a better approximation of the level of regulation since a treaty is only binding after it has been ratified. The second point is that there is a level of arbitrariness in choosing the cut off date. For instance the author could have chosen to investigate whether or not a country has signed the treaty in 1988 instead of 1989. Per Fredriksson and Noel Gaston (2000, 360) found, among others, that the choice of the cut off date influenced their results. These authors used the time it took for a country to ratify a treaty as the measure for the strength of domestic regulation in order to circumvent this problem. They have chosen to analyse data from only one treaty, the United Nations Framework Convention on Climate Change (FCCC). They found that democracies ratified faster than non-democracies and that countries that emitted a lot of CO_2 ratified faster. They interpret this last counter-intuitive result as meaning that, large polluting nations where under great internal or external pressure to ratify. The other variables used in the analysis and which proved to have no significant (10%) effect where:

- International trade. They used the imports plus exports divided by the GDP as a measure of international trade and a dummy devised by Sachs and Warner (1995) denoting the absence of government imposed restriction on international trade.
- The population and the land area. Both used as a proxy for the resources available to a country.
- A dummy denoting whether the country is socialist or not.
- The growth of GDP per capita between 1983-1989, used as a proxy for unemployment rates.
- A dummy for OECD. OECD countries have stricter obligations under the FCCC then other countries.
- Dummies denoting whether a country lies in the tropics and whether a country lies south of the Capricorn tropic and a variable representing length of the coastline are used as proxies for the risk countries are running from global warming.
- The life-expectancy, which is a proxy for the planning horizon.

Eric Neumayer (2002) extended this analysis to six other treaties. These treaties were analysed separately. Three treaties were analysed by looking at whether they were ratified and three were analysed by looking at how long it took them to be ratified. The explanatory variables used, were the GDP per capita, democracy, the population, several variables denoting the openness to international trade, and several variables denoting the importance of the industry effected by the treaty (each treaty has its own variable, since it is difficult to measure it in one uniform variable). The variables denoting the openness to international trade where: a dummy denoting whether a country was a member of the World Trade Organisation, the exports plus the imports as a share of GDP, the exports as a share of GDP, the imports as a share of GDP and two indexes developed by the Fraser institute and the Heritage Foundation respectively. None of these opennness variables consistently appears to be a statistically significant explanatory variable, but taken together they suggest that openness to trade tend to have a positive impact on ratification although this effect is not very robust. The importance of the effected industry and the GDP per capita do not play consistent role. Democracy and the population have generally a positive role on ratification.

The fourth study uses an altogether different approach. It uses an index of the strength of environmental policy based on reports prepared for

United Nations Conference on Trade and Development for a sample of 31 countries. (Dasgupta et al. 2001) This measure is strongly and positively correlated with national income per capita. Institutional variables yield less clear results. Variables representing the effectiveness of judicial and administrative system and protection of property rights are significant. Variables that capture the amount of popular representation and freedom of information yield insignificant or perverse results (more freely available information leads to lower levels of regulation). The study does not introduce a variable representing the importance of international trade.

Summing up, the evidence on the effect of openness to international trade is mixed. Per Fredriksson and Noel Gaston (2000) found a non-significant negative impact of international trade on the level of regulation while Eric Neumayer (2002) found a not very robust positive effect of international trade. This is not surprising since the theory told us that international trade will sometimes have a positive influence and sometime a negative influence, depending on the circumstances. Both studies did not control for this and were thus measuring a net effect, which can be either positive or negative depending on the situation. The effects of other variables were found to be more consistent. Most studies conclude that democracy and GDP per capita have a positive effect on the level of regulation. Variables denoting the availability of resources to a country (which could also be interpreted as denoting the size of a country) are generally not significant. Variables on the importance of the effected industry do not seem to have a consistent effect. Furthermore, it was shown that it is preferable to use the time till ratification instead of a dummy denoting whether country has ratified. The reason for this is that the results of the latter seem to depend quite heavily on the chosen cut-off date. Noteworthy is that all studies using data on treaties use only a limited number of treaties and analyse them separately. This paper will improve upon these studie in two ways. First, the different effects of international trade will be disentangled, so its is no longer the net effect of international trade that is being measured. Second, a larger number of treaties will be analysed together, in order to look at the big picture and beyond the peculiarities of individual treaties.

4.3 Studies whereby the level of regulation explains trade

As was already mentioned in the introduction, studies that investigate the effect of regulation on international trade can provide clues as to whether there is a real chance that regulation leads to the loss of an industry and as to the effectiveness of low levels of regulation as a subsidy. Adam Jaffe, Steven Peterson, Paul Portney and Robert Stavins (1995) provide a review of studies that try to find whether environmental regulation has eroded the competitiveness of countries. They find that "studies attempting to measure the effect of environmental regulation on net exports, overall trade flows, and plant-location decisions have produced estimates that are either small, statistically insignificant, or not robust to test of model specification." (Jaffe et al. 1995, 157-58) For instance one of the studies reviewed was a study by James Tobey (1990). It found no impact of environmental regulation on the exports of polluting industries. He uses resource endowments of 23 countries and a qualitative variable representing the strength of environmental regulation to explain the exports of polluting industries in 1975. The variable representing the strength of environmental regulation is based on UNCTAD survey held in 1976. Environmental regulation is in this study expected to influence the amount of the resource environment that is available for production. Stricter regulation means that less environment is available for use in the production process. Stricter regulation thus result in a loss in competitiveness and will reduce exports. However, this effect did not show up in the data.

Two more recent studies confirm that the general conclusion that environmental regulation has little or no effect on the competitiveness of countries. The first one is by Xinpeng Xu (1999) and uses a very rough measure of the level of environmental regulation. Basically he assumes that the level of environmental regulation in OECD countries has risen much faster between 1965 and 1995 than in developing countries. He uses a dataset of exports in environmentally sensitive goods of 34 countries between 1965 and 1995. If environmental regulation has a negative effect on the competitiveness of the regulated industries, than the exports of these industries should have become less important over time for the OECD countries. However, no such changes where found, indicating that environmental regulation does not have an important impact on the competitiveness of industries.

The second study is by Mark Harris, Lázló Kónya and Lázló Mátyás (2002). It explains the imports of one country from another country by the GDP, the population and the land areas of both countries, the distance between the countries, dummies indicating whether the countries are adjacent, both members of the EEC or the EFTA or NAFTA and the stringency of environmental regulation in both countries. It uses six different measures for the level of environmental regulation, all based on either the energy consumption or supply in the country. If the level of the environmental regulation is high in the importing country then we expect the country to import more then when it is low.[1] If the level of the environmental regulation is high in the exporting country then we expect the country to export less then when

[1] This is only true if the regulation deals with the way in which the product is made (e.g. polution caused by the production process) and not with the quality of the good (e.g. faulty wiring in a hairdryer), since a ban on imports is much easier to justify and control for the latter case than for the former.

it is low. The effects of the level of environmental regulation proved to be insignificant in this study too.

In short, there is quite a lot of empirical evidence that environmental regulation has had little or no effect on the competitiveness of countries. There are several possible explanations for this. First of all, the data on the strength of regulation is very poor, which could make an effect of regulation on competitiveness very difficult to observe. Second, the cost of complying with regulation is for most industries a tiny fraction of the total production costs. According to the EPA the cost of complying with federal environmental regulation in the U.S. is on average two percent of total production costs. (Jaffe et al. 1995, 158) Third, there is evidence that firms investing in foreign countries are reluctant to build less-than-state-of-the-art plants. This would mean that the opportunities for business created by differences in regulatory strength are not always as big as they may seem at first glance. (Jaffe et al. 1995, 158) Finally, only the effects of regulations that were actually implemented were measured. Governments might have taken the effect of competitiveness into account and implemented only regulations that do not hurt as much or accompanied regulation with compensating measures or subsidies. There is for instance some empirical evidence that environmental regulation and subsidies to the effected businesses are positively correlated in the agricultural sector. (Eliste and Fredriksson 2002)

4.4 Conclusions

Two types of studies were discussed in this chapter. The first consists of four studies that try to explain the level of regulation. Two of these used international trade as one of the explanatory variables. One study found a non-significant negative effect of international trade while the other found a not very robust positive effect of international trade. However, they did not control for the fact international trade might have different effects under different circumstances. So the different results could be due to the fact that both of them were measuring a net-effect. Apart from that, these studies found that wealth and democracy have a positive effect on the level of regulation, just as was hypothesised in chapter 3. The hypotheses that treaties dealing with specific industries are ratified faster than treaties dealing with general issues and treaties with a larger territorial scope are ratified slower are not tested. Furthermore these studies used only a limited number treaties and analysed them separately. This study will in two ways improve upon these earlier studies: First, by simultaneously analysing a larger number of treaties thus making the idiosyncrasies of individual treaties less influential, and second by estimating the different effects of international trade under some of the circumstances discussed in chapter 2.

The second type of studies that was discussed in this chapter consisted of studies that tried to explain patterns of trade by the level of regulation. This type of study is relevant since a negative effect of regulation on the competitiveness is a necessary condition for the hypothesis that international trade might work through the cost of relocating resources between industries and might support the notion that low levels of regulation could be seen as a subsidy. However these studies generally did not found such a negative effect of regulation. This result would thus suggest that the effect of international trade through the cost of shifting resources between industries or through the non-competitiveness of the regulated industry is small or even non-existent.

Chapter 5

Data and Method

5.1 Introduction

The main question of this paper is whether the importance of international trade in an economy influences the level of domestic regulation. The data and the method used to answer this question will be discussed in this chapter. The results from the analysis will be reported in chapter 6. This chapter will consist of three parts. The first part discusses the data, the second the method and the last part the relationship between the theory and the data.

5.2 The data

5.2.1 General structure

The data will be used to investigate the relation between international trade and the level of regulation. The level of regulation will be measured by the time it takes to ratify a treaty.[1] Multiple treaties will be analysed simultaneously in order to reduce the influence of the peculiarities of individual treaties. This means that each observation in the dataset corresponds to a country that can ratify a specific treaty. So, if there are two countries, say the United States and Botswana, which could both ratify two treaties, say an environmental and a labour treaty, than the dataset would consist of four cases: US/environment, US/labour, Botswana/environment and Botswana/labour. Note that both the treaties and the countries can appear multiple times in the dataset. The number of times a country appears in the dataset is the number of treaties a country could ratify. The dataset consists of 45 treaties, so the same country could appear at most 45 times in the dataset. The maximum number of times a treaty can appear in the dataset is the number of

[1] This section only describes the data. The justification of the measures will occur in section 5.4, because it can more easily use information from section 5.3 on the method of analysis.

countries that could ratify the treaty. Since there are 104 countries in the dataset the maximum number of times a treaty can appear is 104 (the number of countries has changed over time, but more on this below). However, not all treaties can be ratified by all countries. If, for instance, the environmental treaty is a local African treaty, it would make no sense to include the United States. In that case the dataset would consist of three cases: US/labour, Botswana/environment and Botswana/labour.

The actual dataset consists of 45 treaties. These treaties deal with either environmental or labour issues since these two subjects play a central role in the discussion (e.g. Bhagwati and Hudec 1996 and Hertz 2001) and there are many treaties dealing with these subjects.[2] The treaties were selected from two lists. The list of environmental treaties comes from ECOLEX (UNEP et al. 2002), a joint project of United Nations Environmental Programme (UNEP), the World Conservation Union (IUCN) and the Food and Agriculture Organization of the United Nations (FAO). The list of labour treaties comes from ILOLEX (ILO 2002), a database maintained by the International Labour Organisation (ILO) and which only includes their conventions. Selection criteria were whether these treaties could be seen as representing a level of labour or environmental regulation, whether the data on ratification was complete, whether a diversity in periods, regions and industries coverd by the treaties was ensured and whether the treaties were open for ratification between 1950 and 1980. The first three criteria are self-explanatory. The last criterion is related to the choice that only the period 1950-1992 will be studied. The dataset will not consider information before 1950 because many of the independent variables are missing for that period. The dataset will not consider information after 1992 because an important measure of international trade (the openness dummy discussed on page 44)will be missing after this date. The treaties must be open for ratification by 1980 in order to give the countries a reasonable amount of time to ratify. A list of the treaties can be found in Appenix A. The countries where selected from a list started by Bruce Russet, David Singer and Melvin Small (1968) and which has been regularly updated by the Correlates Of War (COW) Project at the University of Michigan. The version of the dataset used is 1997.1 (Correlates of War Project 2001). A country is included in the dataset when it is independent and when it would be meaningful for that country to ratify the treaty. For example it would not be considered meaningful for St. Kitts and Nevis to ratify a treaty concerning pollution of the Rhine. However, a number of countries are *de facto* excluded because one or more explanatory variables are completely missing.[3] A list of countries used in the analysis

[2]Other policy areas where international trade is supposed to have an influence on the level of regulation are consumer safety/food safety (e.g. Vogel 1995) and competition policy (e.g. Noll 2000). However issues in these areas are seldom dealt with in a separate treaty.

[3]Furthermore, this dataset excludes countries with a population less than 500,000

and the treaties they can ratify is presented in appendix B. The complete dataset consists of 5,170 cases or ‘treaty-countries’.

5.2.2 The dependent variable

As was stated in the previous paragraph the time it takes a country to ratify a treaty is the dependent variable in the dataset. This choice will be justified in paragraph 5.4.1. The time till ratification will be referred to as the duration. In order to determine the duration one should have for each treaty:

- the date after which a country can ratify the treaty, or the begin date and
- the date when a country has ratified the treaty, or the end date.

The begin date represents the begin of the period whereby the country is “at risk” of ratifying the treaty. Both the country and the treaty should exist for a country to be at risk of ratifying. Therefore the begin date can occur for two reasons:

- The treaty has come into existence while the country is independent and it is reasonable to assume that the country could meaningfully ratify it.[4]
- the country has become independent while the treaty existed and it is reasonable to assume that the country could meaningfully ratify it.

This is illustrated in table 5.1. It represents the example dataset consisting of two countries (the USA and Botswana) that could ratify two treaties (an environment and a labour treaty). For simplicity sake the time in this example is measured in years. However, the duration is measured in months in the actual dataset. Since the United States became independent before 1950, the time it takes to ratify is the difference between the date of ratification and the data of adoption. Case three is an example of a case in which the date of adoption occurs before the date of independence. It seems unreasonable to assume that a country could ratify a treaty before it was independent, so the time it takes to ratify is the difference between the date of ratification and the date of independence. Case four is a normal case again, whereby the state was independent when the treaty came into existence.

Case two is an example of common problem with this type of data. America has not (yet) ratified the labour treaty, so it is impossible to calculate the

heads.

[4]A treaty comes into existence when it is adopted. Adoption is the formal act by which negotiating parties establish the form and content of a treaty, e.g. voting on the text, initialling, signing, etc.

Table 5.1: duration

case	country	treaty	indepen-dence	adoption	ratifica-tion	duration
1	USA	environment	1776	1955	1964	9
2	USA	labour	1776	1970	-	?
3	Botswana	environment	1966	1955	1968	2
4	Botswana	labour	1966	1970	1984	14

amount of time it takes the USA to ratify the labour treaty. This is called right censoring. Normally, missing values are discarded. However, if case two had been excluded from analysis the mean duration would be underestimated. In this example the mean time it takes to ratify a treaty, excluding case two is 8.3 years. However, table two does give some information about the duration of case 2: the USA did not ratify the treaty before the time when the analysis stopped, i.e. 1992. So ratification took at least more than 22 years. That means that the average duration should be longer than 11.8 years. The information that is available in censored cases is used in survival analysis, the statistical techniques that will be used in analysing the data. These techniques will be discussed in more detail in section 5.3 and in appendix D, but the important thing now is how this works out in the dataset. If the case is censored than duration takes the value of the time during which it is known that the country has not ratified. A dummy is added and this dummy takes the value one if the case ends in ratification and zero if the case is censored. Duration now has a double meaning: if the dummy equals one the duration means the time needed to ratify and if the dummy equals zero the duration means the time during which it is known that the treaty has not been ratified. The new duration variable in combination with the dummy gives all the information available about the time it takes to ratify a treaty. Table 5.2 shows how this would work out for the example. The question mark in the duration variable in case 2 is replaced by the number of years the USA is known not to have ratified the labour treaty. In addition the dummy 'ratified' has the value zero for case two, indicating that it is censored. In the actual dataset only 27% of all treaty-countries have ended in ratification before 1992. This means that, a simple way of describing the data, like the mean or median are distorted by this large number of censored data. For this reason a meaningful description has to wait until chapter 6.

To sum up, the duration is thus calculated by subtracting the begin date from the end date. The begin date is either the date of adoption of the treaty or the date of independence of the country, whichever comes last. The end date is either the date of ratification or december 1992, whichever comes first. So constructing the independent variable requires the dates of adoption of all treaties, the dates of independence of all countries and the

Table 5.2: duration with a censored case

case	country	treaty	indepen-dence	adop-tion	ratifica-tion	dura-tion	ratifica-tion
1	USA	environment	1776	1955	1964	9	1
2	USA	labour	1776	1970	-	22	0
3	Botswana	environment	1966	1955	1968	2	1
4	Botswana	labour	1966	1970	1984	14	1

dates of ratification if ratification occured before januari 1993. The date of adoption and the dates of ratification where obtained from ECOLEX (UNEP et al. 2002) for the environmental treaties and ILOLEX (ILO 2002) for the labour treaties. The dates of independence where obtained from the list maintained by Correlates Of War Project (Correlates of War Project 2001).

5.2.3 The independent variables

The decision on which explanatory variables are added to the dataset is based upon the theory and the availability of data. The theory provides the theoretical concepts that should be measured by the explanatory variables and the availability of data determines which concepts can be measurd. This section will describe these independent variables and state which theoretical concept is measured by which variable. These choices will be justified in section 5.4. Where possible, multiple variables will be used to measure the same concept in order to assess the robustness of the results. One can be more confident in the results if different variables support the same conclusion. A different way of reducing the influence of peculiarities of individual measures is to combine these different measures into one index. However, these combined indexes either have a low reliability, indicating that they measure different aspects of the concept they are supposed to measure, or the different measures are basically different manipulations of the same data (e.g. volume of international trade in current or in constant prices). So comparing the results from the different measures is preferred above combining them into one index. A table listing all explanatory variables can be found in appendix C.

The size of the country

The size of a country should be measured because the theory predicted that large countries will ratify a treaty faster than small countries. Three measures of size are used: GDP, population and a dummy variable denoting the difference between members of the G7 and non-members. GDP is the total production in a country and can measured in many different ways. The measure that will be used here controls for the fact that one can buy much

Table 5.3: size measured by G7-membership

case	country	treaty	duration	ratified	G7
1	USA	environment	9	1	1
2	USA	labour	22	0	1
3	Botswana	environment	2	1	0
4	Botswana	labour	14	1	0

Table 5.4: size measured by G7-membership and GDP

case	country	treaty	year	duration	ratified	G7	GDP
1	USA	environment	1955	1	0	1	2012
1	USA	environment	1956	2	1	1	2054
3	Botswana	environment	1966	1	0	0	0.55
3	Botswana	environment	1967	2	1	0	0.66

more with one dollar in say India than in the USA (that is, purchasing price parities or ppp's are used) and for the fact that one could buy much more with one dollar in 1950 than now (that is, constant ppp's are used). Both the GDP and the population data are obtained from the Penn World Tables version 6.1. (heston et al. 2002) Two things should be noted about these variables. First, These variables are all characteristics of the country in the country-treaty cases. This can be seen in the example in table 5.3. Second, the values of the variables GDP and population can change over time. The cases are split into different records (rows) each representing a calendar year, in order to facilitate this. Case one from the example would be split up in 9 records, case two in twenty, etc. This is illustrated in table 4 below. It shows the hypothetical environmental treaty from the example, only it will be assumed that the USA and Botswana ratify it in the second year, to keep the size of the table small. The variable year tells which year the record represents. The variable duration now tells the number of years the treaty was not ratified at the end of the record. So at the end of 1955 (in the first record) the time the treaty was not ratified for case one was one year, while at the end of 1956 (the second record) this was 2 years. The variable ratified now tells whether the country has ratified the treaty at the end of the record. So in the first records of both cases the value of ratified is zero and in the second records the value is one. If one of the cases was right censored the value of ratified would always remain zero. Variables, which are constant over time like G7, will have the same value in all record, while time varying variables like GDP or population will have different values for each record. All this is illustrated in table 5.4.

Table 5.5: non-competitiveness of regulated industry

case	country	treaty	duration	ratified	non-competitive
1	USA	environment	9	1	1
2	USA	labour	22	0	0
3	Botswana	environment	2	1	1
4	Botswana	labour	14	1	0

The competitiveness of the regulated industry

The competitiveness of the regulated industry should be measured because theory predicted that regulations that deal with imperfectly competitive industries will be adopted at a slower rate than regulations dealing with competitive industries. The competitiveness will be measured by dividing the treaties into three categories: treaties dealing with a competitive industry, treaties dealing with a non-competitive industry and treaties dealing with general issues. This is done by adding two dummies, one differentiating between treaties dealing with competitive and non-competitive industries and the other differentiating between treaties dealing with competitive industries and treaties dealing with general issues. The competitiveness is measured by the first dummy. Note that this variable is a characteristic of the treaty in the country-treaty cases. This may seem odd, but it is assumed that competitiveness is more the result of the intricacies of the industry than of the intricacies of the country and the industry effected by the treaty is a characteristic of the treaty. This can be seen in the example in table 5.5. The environment treaty is assumed to deal with a non-competitive industry and the labour treaty with a competitive industry.

Nine industries are present in the actual dataset: Agriculture, Fishery, cargo handling, road transport, trade in wild animals and plants, chemical industry, cars manufacturing, shipping and mining. The first five are considered competitive, while the last four are non-competitive. The main justification of this is that most of these industries are archetypal competitive or non-competitive industries.

The presence of important higher standard trading partners

The importance of higher standard countries should be measured because the theory predicted that the speed of ratification increases when there are important trading partners with higher levels of regulation. The importance of higher standard countries is measured by the sum of the GDP of all countries that have already ratified the treaty. If no data on the GDP of a country was available an estimate of the GDP based on a regression of GDP on population of similar countries was imputed. This variable is again a characteristic of the treaty in the country-treaty cases. Furthermore the value of this variable changes over time.

International trade

International trade will be measured in three ways: First as the volume of international trade as a share of GDP in current prices. Second as the volume of international trade as a share of GDP in constant prices. Both are obtained from the Penn World Tables (heston et al. 2002). Third as a dummy devised by J.D. Sachs and A. Warner (1995) denoting whether a country is open or closed to international trade. A country is coded as closed when one of the following conditions is met:

- Nontariff barriers covering 40 percent or more of trade.
- Average tariff rates of 40 percent or more.
- A black market exchange rate that is depreciated by 20 percent or more relative to the official exchange rate, on average, during the 1970s or 1980s.
- A socialist economic system
- A state monopoly on major exports.

The theory predicts that the effect of international trade changes when the size of the country, the competitiveness of the regulated industry or the importance of higher standard countries changes. These effects are measured with Interaction terms with the size variables, the competitiveness dummy and the sum of GDP variable. An interaction term is simply the product of variables. For instance, if we measure size by the variable G7 and international trade by the volume of international trade relative to GDP in current prices, than the interaction term would be the product of both variables. Lets assume that we are estimating the model represented by equation 5.1. $\ln T$ is the natural logarithm of the duration, trade is the volume of international trade, G7 is the dummy representing membership of the G7, G7*trade is the interaction term, the betas are the effect of their variables, and ε is a normally distributed error term[5].

$$\ln T = \beta_0 + \beta_1 G7 + \beta_2 trade + \beta_3 G7 * trade + \varepsilon \tag{5.1}$$

The effect of trade can be rewritten as $(\beta_2 + \beta_3 * G7)\, trade$. If the country is not a member of the G7, i.e. G7 is zero, than the effect of openness is $(\beta_2 + \beta_3 * 0) = \beta_2$. When the country is a member of the G7 than the effect

[5]This is just one of many models that can be estimated with survival analysis. Other models will be discussed in appendix D.

of openness is $(\beta_2 + \beta_3 * 1) = \beta_2 + \beta_3$. Similarly the effect of G7 membership can be rewritten as $(\beta_1 + \beta_3 * trade)$. That means that the effect of size when a country does not trade at all is captured by β_1 and β_3 captures the increase of the effect for every unit increase in trade. It would be much more interesting if β_1 captures the effect of size when a country does a average amount of international trade, since zero international trade is not a realistic value. This is done by subtracting the average value of trade from the trade variable and using this rescaled variable instead. Openness measured by the volume of international trade, the GDP, the population, and the sum of GDP of all countries that have ratified are all rescaled in that way.

The strenght of the business lobby

The strength of the business lobby should be measured because regulations that face a strong business lobby are expected to be lax. This concept is measured by the dummy that differentiated between treaties dealing with competitive industries and treaties dealing with general issues which is discussed on page 43. This dummy is a constant variable, which is a characteristic of the treaty.

The level of democracy

The level of democracy should be measured because the theory predicted that democracies will have higher levels of regulation than non-democracies. The level of democracy is measured in two ways: The first way uses the Polity IV dataset (Marshall and Jaggers 2000) and the second uses a dataset by Tatu Vanhanen (2000). The variable used from the Polity IV dataset is called polity and ranges from –10 (strongly autocratic) to 10 (strongly democractic). This variable is based upon the scores of the following component variables (Marshall and Jaggers 2000, 17-23):

- Regulation of Chief Executive Recruitment: This refers to the extent to which a polity has institutionalized procedures for transferring executive power.
- Competitiveness of Executive Recruitment: Competitiveness refers to the extent that prevailing modes of advancement give subordinates equal opportunities to become superordinates.
- Openness of Executive Recruitment: Recruitment of the chief executive is "open" to the extent that all the politically active population has an opportunity, in principle, to attain the position through a regularized process.

- Executive Constraints: This variable refers to the extent of institutionalized constraints on the decision-making powers of chief executives, whether individuals or collectivities.
- Regulation of Participation: Participation is regulated to the extent that there are binding rules on when, whether, and how political preferences are expressed.
- The Competitiveness of Participation: The competitiveness of participation refers to the extent to which alternative preferences for policy and leadership can be pursued in the political arena.

The problem with the polity variable is that the theory allowed for a non-linear relationship between the level of democracy and the speed of ratification since semi-democracies could ratify slower than both democracies and dictatorships. Furthermore, the values –10 till 7 basically represented dictatorships, 7 till 9 semi-democracies and 10 democracies. That means that the step from say –10 to –9 is smaller than the step from 9 to 10, while adding the polity variable *as is* would presume that these steps are equally large. The polity variable was for these reasons transformed into two dummies: one denoting the difference between democracies and dictatorships and one denoting the difference between semi-democracies and dictatorships. The second way of measuring democracy is based upon a dataset by Tatu Vanhanen (2000). He combined the percentage share of votes for the opposition parties and the percentage of the adult population that voted in the election to get a variable that represented the percentage share of the population that voted for the opposition. This variable encompasses the two main dimensions of democracy: the level of competition and the level of participation. (Vanhanen 2000, 253) This variable was transformed into two dummies: one denoting the difference between democracies (more than 25% of adult population voted for opposition) and dictatorships (0% of the adult population voted for the opposition) and one denoting the difference between semi-democracies (between 0 and 25% of the adult population voted for the opposition) and dictatorships. Both the Polity IV and the Vanhanen dummies are characteristics of the country in the country-treaty cases and are variable over time.

The wealth of a country

The wealth of a country should be measured because the theory predicted that richer countries would have a higher level of regulation. The wealth of a country is measured by the real GDP *per capita* in dollars at 1996 prices. The GDP *per capita* was measured in constant PPPs, just as the GDP. This variable is a characteristic of the country in the country-treaty cases and is variable over time.

The territorial scope of the treaty

The territorial scope of the treaty should be measured because the theory predicted that treaties with a smaller territorial scope will be ratified faster than treaties with a larger territorial scope. The territorial scope is measured by two dummies. One differentiates between global (covering all countries) and local treaties (covering a part of a continent), and the other differentiated between regional (covering (a major part of) a continent) and local treaties. These dummies are characteristics of the treaty and they are constant over time.

Other variables

Three other variables are added to the dataset because they improve the fit of the models. However no predictions were made about their effect. The first variable is a dummy denoting whether the treaty is a labour or an environment treaty. The second variable is a dummy denoting whether the case started when the treaty came into existence or when the country became independent. The third variable represents the economic growth in the past five years. This variable comes from the Penn World Tables (heston et al. 2002).

5.2.4 Characteristics of the independent variables

Information on missing values, some basic statistics like the mean and the standard deviation and the correlation between the variables are crucial in interpreting the results of the analysis. Missing values mainly come from the Penn World Tables and the Polity IV dataset. The Penn World Tables provides no information on 10 states: Cuba, Albania, Equatorial Guinea, Libya, Lebanon, South Yemen, Afghanistan, North Korea, Cambodia, North and South Vietnam. In 2001 the population of these countries together was about 170 million or about 3% of the world population. The remaining countries either have more than ten missing values (Twenty-six countries, many of them former communist countries.) or no more than two or three. The Polity IV dataset provided no information on the following 20 countries: Antigua & Barbuda, Bahamas, Barbados, Belize, Brunei, Cape Verde, Dominica, Grenada, Maldive Islands, Malta, Sao Tome-Principe, Seychelles, Solomon Islands, St. Kitts-Nevis, St. Lucia, St. Vincent and the Grenadines, Surinam, Vanuatu and Western Samoa. Missing values of both the PWT and the Polity IV data were replaced with their previous value if the number of missing values was no more than four. More detailed information on missing values is presented in table 5.6.

Table 5.8 presents some basic desciptive statistics of the variables. Note that the number of observations is much higher than the number of cases in the previous table. The reason for this is that an observation in this table

Table 5.6: missing values

subjects for whom the variable is:	constant	varying	never missing	always missing	sometimes missing
global	5170	0	5170	0	0
GDP	229	4313	3682	628	860
GDP*current trade	229	4313	3682	628	860
GDP*constant trade	229	4313	3682	628	860
GDP*open	1361	1809	2915	2000	255
population	231	4365	3691	574	905
population* trade	230	4361	3682	579	909
population*open	1361	1809	2915	2000	255
G7	5170	0	5162	0	8
G7*trade	4355	236	3681	579	910
G7*open	3142	43	3121	1985	64
noncompetitive	5170	0	5170	0	0
noncompetitive * current trade	3240	1351	3682	579	909
noncompetitive * constant trade	3300	1351	3742	519	909
noncompetitive * open	2842	343	3121	1985	64
general	5170	0	5170	0	0
sum of GDP	463	4707	5170	0	0
sum of GDP * current trade	230	4361	3682	579	909
sum of GDP * constant trade	290	4361	3742	519	909
sum of GDP * open	1376	1809	3121	1985	64
current trade	230	4361	3682	579	909
constant trade	290	4361	3742	519	909
open	2176	1009	3121	1985	64
mean growth	82	4117	2506	971	1693
democracy Polity IV	4368	159	3429	643	1098
semidemocracy Polity IV	3701	826	3429	643	1098
democracy Vanhanen	4546	590	5079	34	57
semidemocracy Vanhanen	2993	2143	5079	34	57
ln GDP per capita	229	4313	3682	628	860
regional	5170	0	5170	0	0
independence	5170	0	5170	0	0
labour	5170	0	5170	0	0

is a record, and a case can consist of multiple records (A case consists of only one record if the country ratifies the treaty in the first possible year). Note also that the number of records that have no missing values on any of the variables is only two thirds of the total number of records. The natural logarithm of the GDP per capita is presented in both tables since this will be the variable used in the parametric and semi-parametric analysis.

Table 5.8: descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
GDP	79796	-151	6618	0	510
population	80817	-32	1133	0	109
member of G7	91643	0	1	.043	.20
noncompetive industry dummy	91658	0	1	.32	.47
general issue dummy	91658	0	1	.34	.47
sum of GDP	91658	-6.38	21.56	0	5.96
international trade in current prices	80268	-63.61	372	0	46.3
international trade in constant prices	80328	-65.38	303	0	48.3
openness dummy	64563	0	1	.34	.48
mean growth in past five years	75921	-16.30	29.47	.16	3.71
democracy Polity IV	80018	0	1	.18	.38
semi-democracy Polity IV	80018	0	1	.12	.32
democracy Vanhanen	90995	0	1	.15	.35
semi-democracy Vanhanen	90995	0	1	.42	.49
ln(GDP per capita)	79796	5.94	10.72	8.14	1.00
dummy global treaty	91658	0	1	93	.25
dummy regional treaty	91658	0	1	.068	.25
independence	91658	0	1	.28	.45
labour or environment	91658	0	1	.60	.49
Valid N (listwise)	58481				

One does not want the explanatory variables to be highly correlated with one-another when one wants to disentangle the effects of the different explanatory variables. The techniques used must be able to distinguish the different explanatory variables in order to determine the unique effects of these variables and it can not do so when the variables are highly correlated. That is, variables can cause multicollinearity problems if the correlation is high. Most of the correlations are significantly different from zero, but this is not surprising given the large number of observations. The correlation between the interaction terms and their constituent variables are generally quite high, as was to be expected. Furthermore, the correlation between openness to international trade, democracy and GDP per capita are quite high (.50 to .59). However none of these correlations, except for the interaction terms, are high enough to cause serious problems. So, only the results from the interaction terms and their constituent parts should, as usual, be treated with some caution.

5.3 Method

This section discusses the techniques used in analysing the data. The dataset consists of the duration to ratification of several environmental and labour treaties and a number of explanatory variables. In short, we want to explain the duration with these explanatory variables. The set of techniques used to achieve this is called survival analysis. Other names for these techniques are event history analysis, duration analysis or transition analysis. Survival analysis assumes that the observed durations are realisations of some random process. We may think of this as countries that every year run a "risk" of ratifying that year. We would expect that the duration is short when this risk is high and long when the risk is low. That risk of ratifying may change from year to year or may be different for countries with different characteristics. The way the risk changes over time is captured by the probability distribution and the different characteristics are captured by the explanatory variables. With survival analysis we can estimate the impact of the explanatory variables on the risk of ratifying. Three techniques have been discussed:

- The non-parametric technique, which makes no assumptions about the functional form of the probability distribution and the way the explanatory variables influence the risk of ratifying.
- The parametric technique, which makes assumptions on both the functional form of the probability distribution and the way the explanatory variables influence the risk of ratifying.
- The semi-parametric technique, which only makes an assumption on the way the explanatory variables influence the risk of ratifying.

This section concentrates on the kind of outcomes these techniques produce and on how to interpret them. A more detailed describtion of these techniques can be found in appendix D.

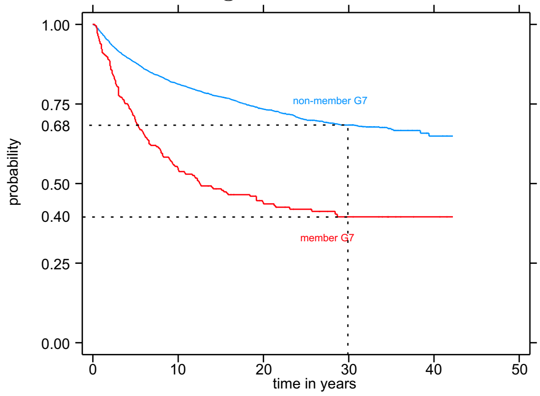
The results obtained from non-parametric analysis are graphs that compare the survival curves of different groups. The survival function represents the probability of not having ratified (surviving) at each point in time, which can also be interpreted as the estimated proportion of the countries that have not ratified at each point in time. The group with the lowest survival function is thus the fastest ratifying group. This is illustrated in graph 5.1. This graph shows that the probability that a country takes more than thiry years to ratify is 68% for non-member of the G7 and 40% for members of the G7. An alternative interpretation would be that after 30 years only 32% of the non-members ratified, while at the same time 60% of the G7-member had ratified. So the fact that the survival curve of the G7 members lies below the survival curve of the non-members means that G7 members ratify faster than non-members.

A problem with non-parametric analysis is that only a limited number of groups can be compared each time because otherwise the graph would become too cluttered to be interpretable and each group would not contain enough datapoints to get a reliable estimate. This technique is consequently not able to test the hypotheses related to international trade since they all involve interaction terms.[6] This technique is however suitable to test the other hypotheses and it can do so without making any assumptions on the distribution of the duration.

Parametric analysis can produce results while controling for many other variables. The results from the parametric technique come in the form of either hazard ratios or time ratios. A hazard ratio is the proportion by which the hazard changes if the explanatory variable increases with one unit. The hazard can be loosely interpreted as the probability of ratifying. So if we find a hazard ratio of G7 of 1.2 and G7 is one when a country is a member of the G7 and zero otherwise, than becoming a member of the G7 will result in a 20% increase of the probability of ratifying. Similarly, a time ratio is the ratio of the time till ratification, if the explanatory variable increases with one unit. So if we find a time ratio of G7 of 1.2, than becoming a member of the G7 will

[6]Furthermore, no non-parametric analysis will be done using the variable representing the sum of the GDP of the countries that have already ratified. The reason for this is that countries that for other reasons ratify fast have not given other countries time to ratify. Consequently, they will have ratified fast and have a low value of the variable sum of GDP. As a result non-parametric analysis will find that low values of the variable sum of GDP are associated with being a fast ratifier. However being a fast ratifier in not caused by low values of the variable sum of GDP, but low values of the variable sum of GDP are caused by being a fast ratifier. This makes this variable especially troublesome for non-parametric analysis, since it does not control for other reasons why a country might be a fast ratifier. This is not a problem for parametric or semi-parametric analysis, since these techniques control for other variables that might cause a country to be a fast ratifier.

Figure 5.1: survival curve by G7 membership



result in a 20% increase in the time till ratification.[7,8] Note that a hazard ratio larger than one means that the risk of ratifying increases and thus the expected time till ratification decreases, while a time ratio larger than one means that the expected time till ratification increases. Additionally, hazard ratios and time ratios with a value of one mean that the explanatory variable does not have an impact. The results from the semi-parametric analysis come in the form of hazard ratios, which are interpreted in exactly the same way as the hazard ratios derived from parametric analysis.[9]

The techniques all have their own advantages and disadvantages. The non-parametric allows us to gain insight with the smallest number of assumptions, but it can only compare a limited number of groups. Consequently it cannot deal with continuous variables or control for other variables. The parametric technique can deal with both discrete and continuous explanatory variables and control for a large number of other explanatory variables.

[7]The GDP per capita is an exception. The fit of the models is improved when the logarithm of the GDP per capita is entered instead of the GDP per capita itself. This means that a dollar increase in wealth has more impact for poor countries than for rich countries. In this case the raw parameter will be reported since it is more informative than the hazard ratio or the time ratio. It can be interpreted as the percentage change in the time till ratification or hazard as a result of a one-percent change in the GDP per capita.

[8]The interaction effects pose a problem. For instance the interaction effect of GDP and international trade measures the increase or decrease of the raw parameter of international trade when GDP increases with one unit (i.e. one milliard dollars) and not the increase or decrease in the hazard ratio or time ratio. There is no easy way to make both the size of the parameters of the 'normal' variables and the size of the parameters of the interaction terms easily interpretable. For this reason only the hazard or time ratios are reported and I accept that the only real information in these ratios for the interaction effect comes from assessing whether they are larger or smaller than one.

[9]The difference between parametric and semi-parametric analysis lies in the fact that parametric analysis requires assumptions on both the distribution of the duration and on the way the explanatory variables influence the duration, while semi-parametric analysis requires only the latter assumption.

However in order to estimate such a model we have to make assumptions on how the probability of ratifying changes over time (time dependence) and on how the explanatory variables influence the risk of ratifying. The semi-parametric technique requires only the last assumption. However the estimated parameters and betas will be less precise then the ones obtained from parametric analysis (provided that the assumptions made in parametric analysis are correct) and we can no longer test hypotheses about time dependence.

5.4 The theory and the data

This section will justify the measures used in the dataset by stating the link between the theory and the models that will be estimated. The empirical model explains the time it takes to ratify a treaty (duration) with a number of explanatory variables. The theory posits a number of causal relations between the level of regulation and a number of theoretical concepts, including international trade. The link between the theory and the empirical models starts with hypotheses derived from the theory. They state the expected effect of the theoretical concepts. These will be transformed into general predictions by justifying the variables as measures of the corresponding theoretical consepts and than replacing the theoretical concepts with the variables. Finaly these general predictions are transformed into specific predictions on the outcomes (the sign of the parameters or the shapes of the graphs) of the different models. However, the first variable that needs justifying is the duration as a measure of the level of regulation.

5.4.1 Justifying the dependent variable

All models use the time till ratification as the means to measure the level of regulation. This measure can be justified in two ways: first, fast ratification of a treaty may indicate "a more intense preference for the provisions it contains" (Fredriksson and Gaston 2000, 347). Second, if we assume that there has been an exogenous upward trend in levels of regulation (due to changes in technology, knowledge and/or ideology), than international trade does not so much impact the level of regulation but the speed at which the regulation rises. A factor that is supposed to raise the level of regulation, will now (temporarily) increase the speed at which the level of regulation rises and a factor that is supposed the decrease the level of regulation will now decrease the speed at which the level of regulation rises. Countries whose level of regulation rises fast will be fast ratifiers and countries whose level of regulation rises slowly will be slow ratifiers. Either way, speedy ratification is associated with high levels of regulation.

Three objections could be made against the time till ratification of treaties as a measure of the level of regulation. First of all, international trade could have had a decisive influence during the negotiations, that is, before ratification of a treaty becomes an issue. In that case the effects of international trade would be incorporated in the text of the treaty and not in the differences in time till ratification. This is however also likely to happen for other explanatory variables like the territorial scope of the treaty and whether a treaty deals with a general issue or a specific industry and these variables will still prove to have a strong influence on the speed of ratification. Second, the ratification of a treaty marks an increase in the level of regulation. Consequently, the time till ratification is better in recording a rise in the level of regulation than a decline in that level. This is not a very big problem since the overall level of regulation has generally risen in the past fifty years (Vogel 1995, 1). As a result, a negative influence of a variable will lead to a slower rise in the level of regulation instead of a drop in the level of regulation. Third, treaties are often seen as not ambitious enough, so ratifying a treaty does not mean that one has achieved a very high level of regulation. However, it will be shown that it takes a long time before a large number of countries have ratified a treaty. If ratifying a treaty were just a hollow gesture, than why would it take so long for countries to ratify it?

5.4.2 Transforming the hypotheses into general predictions

The relationship between the theoretical concepts and the explanatory variables will be discussed per hypothesis. Two groups of hypotheses are distinguished: Those related to international trade and those related to control variables. The trade related hypotheses will concentrate on ways in which international trade can detract from the optimal level of regulation.[10] Four such reasons are distinguished. These are: the country is so large that it can influence world prices, the regulated industry is non-competitive, there are important other countries with higher levels of regulation, and shifting resources between industries is costly. The the control variables are necessary to estimate the parametric and semi-parametric models. The hypotheses concerning the control variables are interesting enough to be discussed here, although they are not directly related to the main question of this paper. The control variables are the influence of special interest groups, the level of democracy, the wealth of a country, and pressure from nearby countries.

[10]I hypothesised that international trade can also influence the level of regulation through changing the optimal level of regulation but testing this would require import and export data on industry level and this is not available for the area and the period covered by this study (almost all countries in the world and 1950-1992). So this effect remains untested in this study.

The country is so large that it can influence world prices

International trade might have a positive effect on the speed of ratification when a country is so large that it can influence world prices. Basicaly, the effect of size counteracts the effect of international trade on the optimal level of regulation. The effect of international trade on the optimal level of regulation ensures that importing countries have higher levels of regulation than exporting countries when these countries allow international trade.[11] Size diminishes this effect. A large country can decrease the price of its imports by relaxing the level of regulation (and thus increase production) or increase the price of its exports by increasing the level of regulation (and thus decrease production). That means that large countries are more similar to one another than small countries. Large countries are predicted to ratify faster than smaller countries, since many treaties have homogenizing characteristics. It also means that size will make international trade have a positive effect on the speed of ratification, since this effect works because of international trade. This leads to the following hypotheses.

h1a Large countries ratify faster.

h1b International trade has a more positive effect in large countries

Three different measures of size will be used. One can be sure that the measured effect of size is not influenced by peculiarities of an individual measure of size if all three generate the same results. The measures of size are the GDP, the population and whether or not the country is a member of the group of seven major industrialised countries (G7). The effect of size on the effect of international trade is measured by interaction terms with the measures of international trade. The interaction terms measure the change in the effect of international trade as a result of a unit change in size. International trade is measured by three variables: one denoting the volume of international trade relative to GDP in current prices, one denoting the volume of international trade relative to GDP in constant prices and one denoting the absence of measures restricting international trade. Hypothesis H1a can now be transformed into the prediction that countries will ratify

[11] The optimal level is determined by balancing the costs and the benefits from the regulation. The costs stem from the reduced production as a result of the regulation. A country can shoose to allow or not to allow international trade. The price of the good will decrease when the country allows international trade and it imports the good. Consequently the value of reduced output and thus the cost of regulation will decrease as a result of allowing international trade. Similarly, the price of the good will increase when the country allows international trade and it exports the good. This means that the value of reduced output and thus the cost of regulation will increase as a result of allowing international trade. The optimal level of regulation will as a result increase when the country allows international trade and it imports and decrease when the country allows international trade and it exports.

faster when they have a high GDP or have a large population or are a member of the G7. Similarly, hypothesis H1b can be transformed into the prediction that having a high GDP or a large population or being a member of the G7 will make the measures of international trade have a more positive effect on the speed of ratification.

The regulated industry is non-competitive

International trade might have a negative impact on the level of regulation when the regulated industry is non-competitive. In this case it becomes attractive to subsidise this industry, since this will increase the domestic share of the rents earned in this industry and/or since the imperfectly competitive firm can have a stronger bargaining position *vis a vis* the government. A low level of regulation is one way of subsidising an industry. This method has the advantage of being less obvious to the own population, foreign firms and governments and thus preventing protests. Regulations dealing with competitive industries are thus expected to be stricter than regulations dealing with non-competitive industries. This effect works because of international trade. The rents that are to be captured must be earned abroad (otherwise the subsidies will only lead to a redistribution of wealth not an increase of wealth) and international trade increases the bargaining position of the firms. So, we expect that non-competitiveness of regulated firms results in international trade having a more negative effect on the speed of ratification.

H2a The level of regulation will be lower when the regulation deals with a non-competitive industries.

H2b International trade has a more negative effect when the regulation deals with a non-competitive industry.

Competitiveness is measured by a dummy which differentiates between treaties dealing with a competitive industry and treaties dealing with a non-competitive industry. The effect of the competitiveness on the effect of international trade is measured by interaction terms with the measures of international trade. Hypothesis H2a can now be transformed into the prediction that treaties dealing with a non-competitive industry will be ratified slower than treaties dealing with a competitive industry. Similarly, hypothesis H2b can be transformed into the prediction that being a treaty dealing with a non-competitive industry will make the measures of international trade have a more negative effect on the speed of ratification.

There are important trading partners that have higher levels of regulation

International trade can have a positive impact on the speed of ratification when important trading partners have higher levels of regulation. The reason for this is that it may be difficult to export to a country if the importing country has higher levels of regulation than the exporting country, either because the people of the importing country prefer high standard goods or because the firms of the importing country resent having to compete with low standard goods and demand a 'level playing field'. Increasing the level of regulation in the exporting country might be a cheap way of signalling compliance with importing countries preferences or standards. This effect is expected to increase the more important the high standard importing countries are and the more important exports are to the exporting country.

H3a The level of regulation will be higher when there are important other countries with a higher level of regulation.

H3b International trade will have a more positive effect on the level of regulation when there are important other countries with a higher level of regulation.

The importance of countries will be measured by their GDP and the importance of all countries with a higher level of regulation will be measured by the sum of the GDP of all countries that have already ratified the treaty. The impact of the sum of GDP on the effect of international trade is again measured by an interaction term with the measures of international trade. Hypothesis H3a can now be transformed into the prediction that countries will ratify faster when there the sum of the GDP of the countries that have already ratified is high. Similarly, hypothesis H1b can be transformed into the prediction that the measures of international trade will have a more positive effect on the speed of ratification when the sum of the GDP of the countries that have already ratified is high.

Shifting resources between industries is costly

International trade can have a negative influence on the level of regulation when relocating resources between industries is costly. Increased regulation may cause an industry to leave a country and thus necessitate a relocation of resources to another industry. The moving away of an industry is in itself not a problem, it is just a way of making the best use of the given resources and preferences for regulation. This may however cause short-term costs like unemployment if the moving of resources between industries is costly. This effect is however not measured, since no variable was found that accurately represents the cost of shifting resources between industries.

Other marketfailures

Some attention was paid to the idea that marketfailures might generally influence the effect of international trade. Marketfailures that necessitate a boost to the economy might lead to a lowering of the level of regulation because too low levels may act as such a boost, regardless of the degree of openness of the country. However, reliable indicators of the presence of market failures are hard to come by. Therefore the average effect of the presence of other market failures (and the cost of the shifting of resources) will be captured by the constant term in the regression.

The influence of special interest groups

Small groups can more effectively organise a lobby than large groups since the benefits have to be shared with less people and the cost of organising are smaller. This means that regulations that target specific industries are subjected to a much stiffer opposition than regulations of a more general nature. This leads to the following hypothesis.

H4 regulations dealing with general issues will be stricter than regulations dealing with a specific industry.

Three categories of treaties are distinguished: treaties dealing with competitive industries, treaties dealing with non-competitive industries and general treaties. The treaties dealing with competitive industry are the reference category. This means that there will be two dummies, one measuring the difference between treaties dealing with competitive and non-competitive industries, and one measuring the difference between treaties dealing with general issues and treaties dealing with competitive industries. Hypothesis H4 can be transformed into the prediction that general treaties are ratified faster than treaties dealing with competitive industries since treaties dealing with competitive industries are expected to be ratified faster than treaties dealing with non-competitive industries.

The level of democracy

Democracies will have higher levels of regulation than non-democracies. The reason for this is that the people in power in a dictatorship have more alternative means to reduce the effect of externalities on themselves apart from regulation, so they are less likely to resort to regulation. Furthermore, a dictator gets/grabs a larger share of national production than the median voter in a democracy. The dictator is thus harder hit by the reduced output as a result of the regulation and is thus less likely to choose for regulation than the median voter in a democracy. The difference in effect of semi-democracies and dictatorships is less clear. Dictators have an incentive to enact regulation that increases production (so there is more for them to tax/steal). Leaders of a semi-democracy may lack the incentive the dictator has and they may lack the incentives that democratic leaders get from elections. In that case a semi-democracy will do worse that a dictatorship. However semi-democracies may also be an intermediate case, whereby a semi-democratic leader gets some but not all of the incentives a dictator has and gets some but not all the incentives a democratic leader has. A semi-democratic country will in that case hold an intermediate position between democracies and dictatorships. This leads to the following hypothesis.

H5 democracies will have higher levels of regulation than semi-democracies and dictatorships.

The level of democracy is measured by two dummies, one comparing democracies with dictatorships and one comparing semi-democracies with dictatorships. Furthermore, two such sets are used. The first set is based on various characteristics of the political system like the competitiveness of the selections procedure of the executive and the constraints placed upon the power of the executive. The second set is based upon the size of the opposition and the turnout during elections. Hypothesis H5 can be transformed into the prediction that democracies ratify treaties faster than semi-democracies and dictatorships.

The wealth of countries

Richer people will demand better environmental quality or working conditions, and thus higher levels of environmental and labour regulation. This leads to the following hypothesis.

H6 Rich countries will have higher levels of regulation than poor countries.

The wealth of a country is measured by the GDP *per capita*. Hypothesis H6 can now be transformed into the prediction that countries with a high GDP *per capita* will ratify faster.

The territorial scope of the treaty

Countries care more about maintaining good relations with their neighbours than with the world as a whole. Treaties made solely with their neighbours will thus be ratified faster than treaties made by a larger group of countries or with all the countries in the world. This leads to the following hypothesis.

H7 Treaties with a small territorial scope will be ratified faster than treaties with a large territorial scope.

In order to measure this effect the treaties where divided into treaties with a local scope (covering a part of a continent), treaties with a regional scope (covering an entire continent) and treaties with a global scope. Hypothesis

H7 can now be transformed in the prediction that treaties with a local territorial scope will be ratified faster than treaties with a regional and global territorial scope and that treaties with a regional territorial scope will ratify faster than treaties with a global territorial scope.

5.4.3 Transforming the general predictions into specific predictions

The general predictions can, with the information from section 5.3, be transformed into specific predictions on the shape of survival curves and the 'sign' of hazard ratios and time ratios. This is done in table 1. It shows those variables that are part of the best model and which measure a theoretical concept. Some control variables, like whether the treaty is an environmental or a labour treaty, have no hypothesis. Some concepts are measured with multiple variables. Different models are estimated using different measures for the theoretical concept in order to determine whether the effect differs when different measures for the same concept are used. Those measures that are not part of the best model are not included in table 5.9. A list of all variables is presented in appendix C.

How the general predictions where transformed can be illustrated by the first two variables. GDP was predicted to increase the speed of ratification. That means that the survival curve of countries with a high GDP will lie underneath the survival curve of countries with a low GDP. The hazard ratio will be larger than one, since having a high GDP will increase the risk/hazard of ratifying. The time ratio will be smaller than one, since having a high GDP will decrease the time till ratification. The second variable is the interaction term of GDP with international trade.[12] A high GDP is expected to make international trade have a more positive effect, i.e. increase the hazard and decrease the duration. The hazard ratio of this variable is thus expected to be larger than one and the time ratio smaller than one. The specific predictions of the remaining variables are made in the same way.

[12] No non-parametric analysis will be done using this variable so no predictions are made on the survival curves.

Table 5.9: Predictions

variable	description	theoretical concept	hypothesis	predictions on survival curve	predictions on hazard ratio	predictions on time ratio
GDP	Total GDP (not GDP per capita) in milliards (10^{12}) of 1996 dollars	size of country	H1a	large countries below small countries	>1	<1
GDP*current trade	interaction term with the current trade variable	impact of size on the effect of international trade	H1b	-	>1	<1
GDP*open	interaction term with the openness variable	impact of size on the effect of international trade	H1b	-	>1	<1
noncompetitive	treaty dealing with non-competitive industry (1= non-competitive industry, 0 = either competitive industry or general treaty)	competitiveness of regulated industry	H2a	non-competitive above competitive	<1	>1
noncompetitive* current trade	interaction term with the trade variable	impact of the competitiveness of regulated industry on the effect of international trade	H2b	-	<1	>1
noncompetitive*open	interaction term with the openness variable	impact of the competitiveness of regulated industry on the effect of international trade	H2b	-	<1	>1
sum of GDP	The sum of GDP of all countries that have ratified the treaty in trillions (10^{15}) of 1992 dollars	importance of high standard countries	H3a	-	>1	<1

variable	description	theoretical concept	hypothesis	predictions on survival curve	predictions on hazard ratio	predictions on time ratio
sum of GDP* current trade	interaction term with the current trade variable	impact of the importance of high standard countries on the effect of international trade	H3b	-	>1	<1
sum of GDP*open	interaction term with the openness variable	impact of the importance of high standard countries on the effect of international trade	H3b	-	>1	<1
general	treaty dealing with general issue (1 = general treaty, 0 = specific industry, either competitive or non-competitive)	power of business lobby	H4	general treaties below specific treaties	>1	<1
democracy Polity IV	democracy according to Polity IV dataset (1= democracy, 0= other)	level of democracy	H5	democracy under semi-democracy and dictatorship	>1	<1
semi-democracy Polity IV	semi-democracy according to Polity IV dataset (1= semi-democracy, 0= other)	level of democracy		-	-	-
ln GDP per capita	logarithm of GDP per capita in 1992 dollars	wealth of country	H6	rich countries under poor countries	raw parameter $> 0^a$	raw parameter $< 0^a$
global	global treaty (1= global treaty, 0 = other)	territorial scope of treaty	H7	global treaties above regional treaties	<1	>1
regional	regional treaty (1= regional treaty, 0 = other)	territorial scope of treaty	H7	regional treaties above local treaties	<1	>1

[a] The raw parameter is in this case more informative. See also footnote 7 on page 52.

Chapter 6

Results

6.1 Introduction

The purpose of this chapter is to find an empirical answer to the main question of this paper: does international trade influence the level of regulation? This is done by testing the predictions developed in the previous chapter. Using the theory as a guide is important since we hypothesised in the theoretical section that international trade could have both a negative and a positive impact on the level of regulation depending on the circumstances. Just adding a measure of international trade to the model, as was done in previous empirical studies, will thus not do, since it would measure the net-effect, and this net-effect is likely to be small. The presentation of the results is organised in three parts, each representing the method used in the analysis. The results from these different methods will be compared to one another in the conclusion.

6.2 Non-parametric analysis

The results of the non-parametric analysis of the variables related to international trade are presented in the graphs 6.1 through 6.7. The main handicap of this technique is that it not practical to control for many variables. Consequently, only preliminary conclusions can be drawn from these graphs. The prediction that large countries ratify faster than small countries is confirmed by graphs 6.1, 6.2 and 6.3. This is to be seen from the fact that the survivor function for large countries (G7-members, position higher up in the population and GDP distribution) is consistently lower than the survivor functions of small countries. The fact that this is true regardless of which measure of size has been used ads robustness to this conclusion. Less clear conclusions can be drawn concerning the prediction that treaties that deal with competitive industries are ratified faster than treaties that deal with non-competitive industries. Graph 6.4 shows that treaties dealing with competitive industries are ratified faster than treaties dealing with non-competitive industries during the first 10 years. Afterwards the difference between these two types of treaties seems to disappear. The same graph is also used to test the prediction that, treaties dealing with specific industries ratify slower than treaties dealing with general issues. This prediction is supported by the graph. Graphs 6.5, 6.6 and 6.7 give the net effect of openness to international trade on the speed of ratification. It would have been a good sign if all graphs would show the same pattern, since they are all supposed to measure the effect of international trade. This is however not the case, the variable denoting the openness to international trade shows a strong positive impact of openness on the speed of ratification, while the impact of the variable denoting the volume of international trade in constant prices shows a negative relation between international trade and the speed of ratification and the variable denoting the volume of international trade in current prices shows a muddled picture.

Figure 6.1: survival estimates by G7-membership

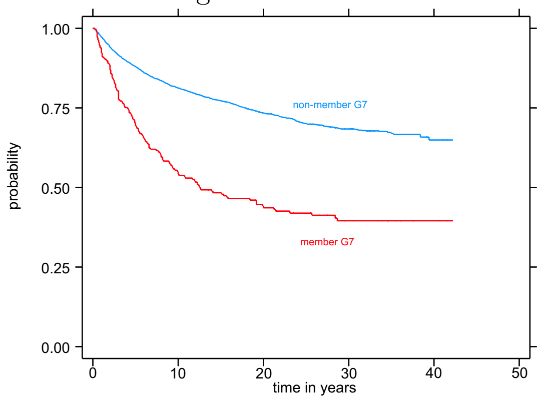


Figure 6.2: survival estimates by population

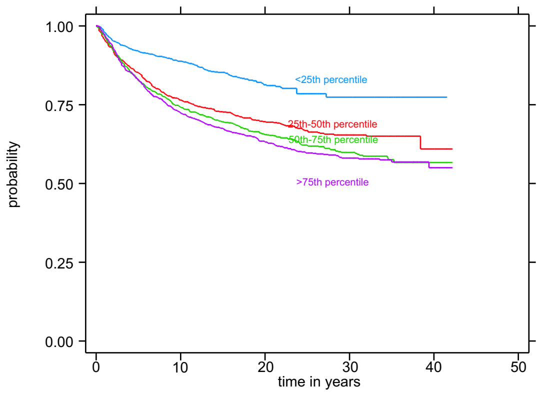


Figure 6.3: survival estimates by GDP

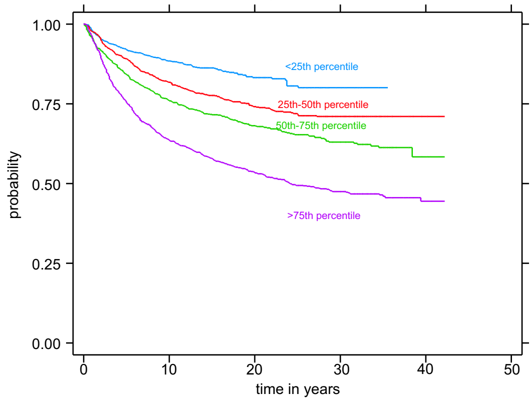


Figure 6.4: survival estimates by industry

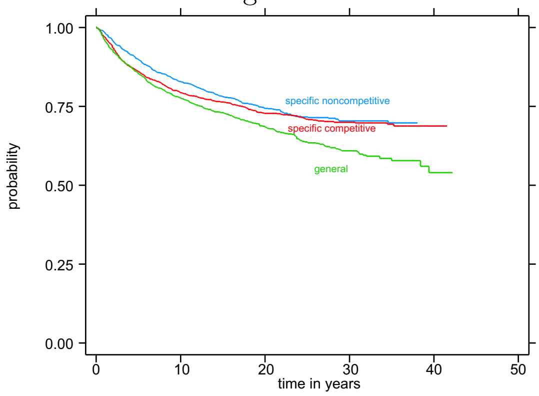


Figure 6.5: survival estimates by volume of trade in current prices

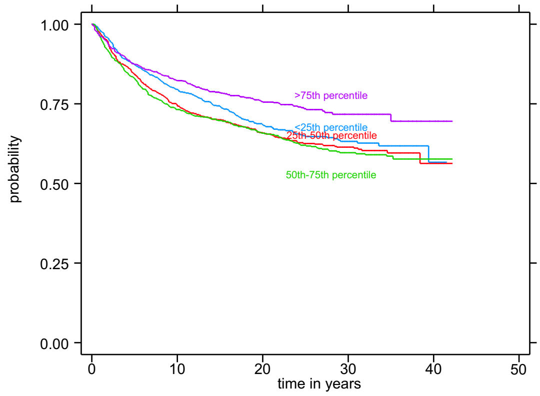


Figure 6.6: survival estimates by volume of trade in constant prices

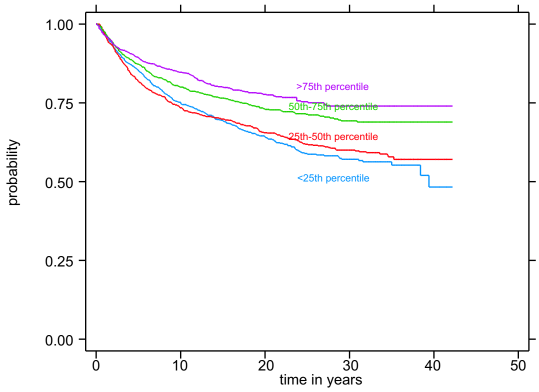
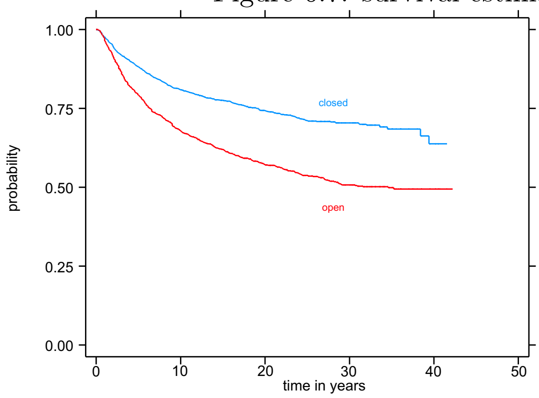


Figure 6.7: survival estimates by openness



Graphs 6.8 through 6.11 represent the control variables. All four graphs support their prediction: democracies ratify faster than non-democracies regardless of which measure of democracy is chosen, rich countries ratify faster than poor countries and local treaties are ratified faster than regional treaties an regional treaties are ratified faster than global treaties.

Figure 6.8: survival estimates by democracy (Polity IV)

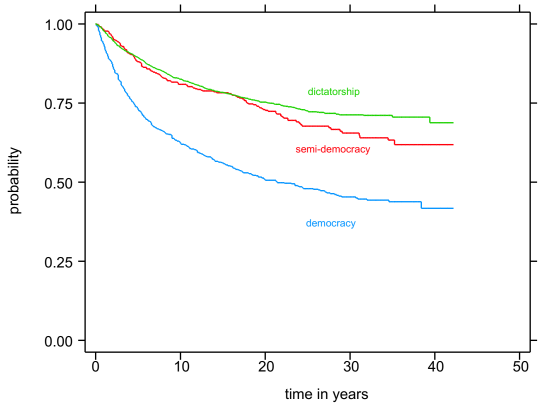


Figure 6.9: survival estimates by democracy (Vanhanen)

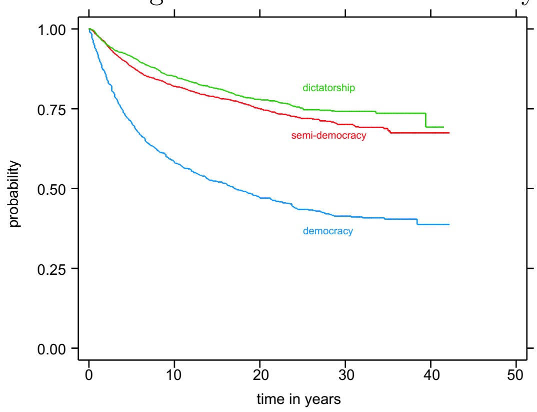


Figure 6.10: survival estimates by GDP per capita

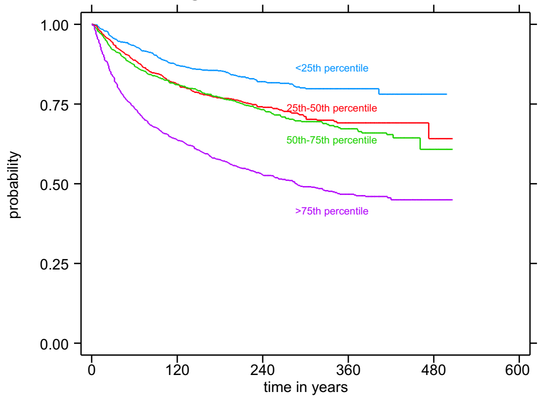
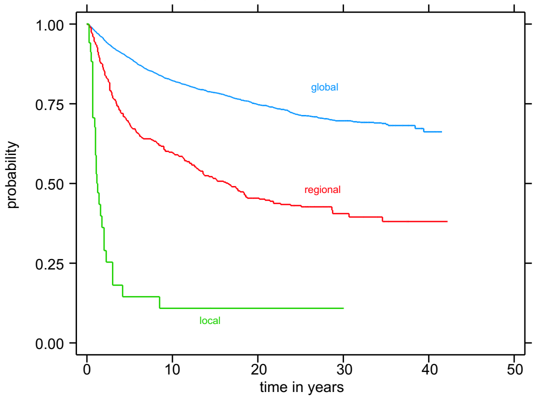


Figure 6.11: survival estimates by regional scope



Finally there are three additional control variables for which no hypotheses where developed. The first one is a variable that differentiates between the labour and the environmental treaties. (graph 6.12). Environmental treaties seem to be ratified faster than labour treaties, but this could be caused by the fact that environmental treaties can be local, regional or global treaties, while only global labour treaties where included in the dataset. The second variable differentiates between cases that start when the treaty comes into existence and cases that start when the country becomes independent (graph 6.13). Cases that start with independence of the country seem to ratify faster in the first three years but after that the cases that began with the start of the treaty catch up. The long run trend can be explained by the fact that countries that have recently become independent are generally poorer and poor countries ratify slower than rich countries as is shown in graph 6.10. Graph 6.14, finally represents the impact of economic growth on the speed of ratification. The first three quartiles seem to indicate that faster economic growth leads to speedier ratification and thus lower survival curves. However the quartile representing the fastest economic growth does not conform to this pattern. This can however be explained by the fact that very high economic growths are generally achieved by relatively poor countries and poor countries ratify later than richer countries.

Figure 6.12: survival estimates by labour

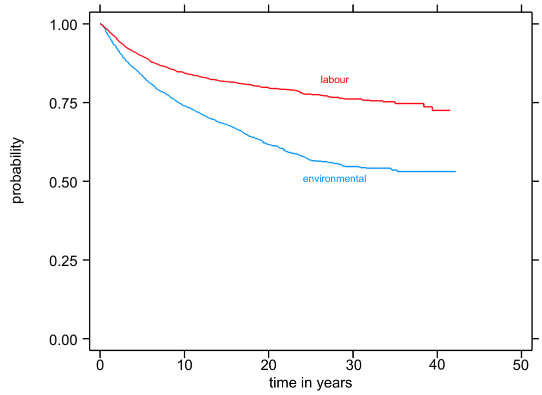


Figure 6.13: survival estimates by independence

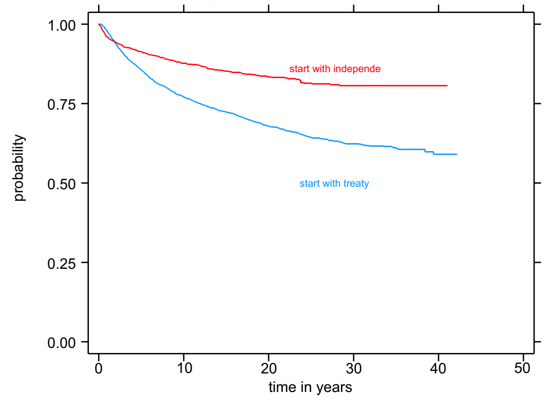
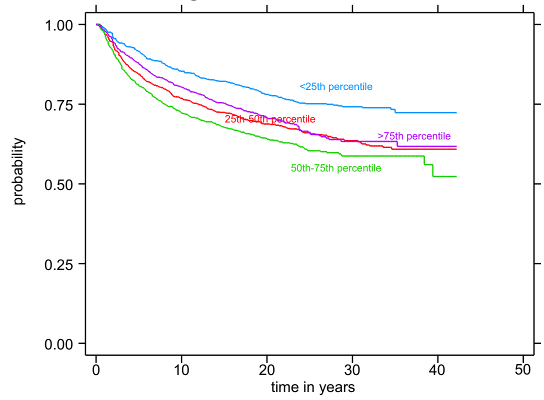


Figure 6.14: survival estimates by economic growth



In short, non-parametric analysis provided clear support for the prediction concerning the impact of whether a country is large or small, whether a treaty is general or industry specific, whether a country is a democracy or not, whether a country is rich or poor and whether a treaty is local, regional or global. Of the effects that were associated with openness to international trade only the size of countries provided a clear support of its prediction. This is however not surprising, since these effects are predicted to be interrelated and we can not control for this in non-parametric analysis.

6.3 Parametric analysis

The first task when doing parametric analysis is to choose the best fitting model. The selection of the best model is described in appendix E. The best fitting model is the log-normal model using GDP as a indicator for size, the openness variable and the volume of international trade in current prices as indicators for international trade and the Polity IV data as an indicator for the level of democracy. The results from this model are presented in table 6.1 below. I hypothesised that international trade could have an impact on the level of regulation through three routes: the country could be large enough to impact world prices, the regulated industry could be non-competitive, or there are important higher standard countries. Table 6.1 supports only the last channel. Being a large country does not speed up ratification. The time ratio has the right "sign", i.e. is smaller than one, but it is not significantly different from one. Furthermore, the interaction terms show that size does not make openness have a significantly (5%) more positive effect on the speed of ratification. The effect of the competitiveness of the regulated industry has the right sign, but is again insignificant. Furthermore, the effect of competitiveness on the effect of international trade is insignificant (if international trade is measured as volume of trade) or it has the wrong sign (if international trade is measured as the absence of restrictive measures). So there is also no support for the hypothesis that non-competitiveness of the regulated industries makes the effect of international trade more negative. The sum of GDP of the ratified countries has the predicted sign and is significant. The ratification of the remaining countries speed up by 11% when a country with a GDP of one trillion 1996 dollars (approximately the UK in the '90s) ratifies. Moreover, the strength of this effect increases with the degree of openness of the country (however the strength of the effect remains unchanged when trade is measured as the volume of trade). So, there is some support for the hypothesis that the pressence of important higher standard countries makes international trade have a more positive effect. The international trade measures now represent a residual effect of international trade, so no predictions where made as to their effect on the speed of ratification. This residual effect is either negative (when international trade is measured as the volume of international trade) or insignificant (when international trade is measured by the absence of restrictive measures). The second column of table 6.1

shows the results of a model that uses only the net effect of international trade. Comparing the log likelihoods shows that adding the different routes through which international trade can influence the level of regulation significantly improves the model (χ^2= 15.77 with 6 degrees of freedom).[1] This means that from the predictions related to international trade only the effect of important high standard countries is supported. The predicted effects of international trade through size and competitiveness were not supported.

Most hypotheses concerning the control variables are supported. General treaties are ratified faster than treaties dealing with a specific industry, rich countries ratify faster than poor countries, and treaties with a small territorial scope are ratified faster than treaties with a larger territorial scope. The only exception is the impact of the level of democracy. A democratic country does not ratify faster than a non-democratic country. Semi-democratic country ratifies slower than both democratic and dictatorial countries.

An important next step is to check whether these results are robust. Robustness means that the results do not depend upon the assumptions. This can be checked by estimating the model with slightly different assumptions and see whether the conclusions remain valid. Appendix F asses the robustness of the findings in two ways: first by comparing the results when different variables are used for the same concept, and second by comparing the results when using different assumptions on the way the hazard of ratifying changes over time. Appendix F concludes that the effect of international trade through the presence of important other countries with high standards did not prove to be robust. The effects of the control variables were robust.

[1]The residual effects of international trade and the net effect of international trade are almost the same. This would seem to suggest that adding these different routes does not make a difference, but the similarity was to be expected since the residual effect measures the effect of international trade when the country has an average size and the sum of GDP has an average value.

Table 6.1: results of parametric analysis, estimates of log-normal model using GDP and Polity IV as indicators for size and democracy respectively (reported coefficients are time ratios.[a] The level of significance is shown in parentheses.)

	with interaction	without interaction
trade related variables		
GDP	.999 (.197)	1.0003 (.007)
GDP*trade	.99998 (.069)	-
GDP*open	1.000 (.514)	-
noncompetitive	1.388 (.086)	1.105 (.490)
noncompetitive*trade	.998 (.614)	-
noncompetitive*open	.564 (.027)	-
sum of GDP	.891 (.000)	.866 (.000)
sum of GDP *trade	1.000 (.488)	-
sum of GDP*open	.940 (.016)	-
trade (current prices)	1.008 (.004)	1.009 (.000)
open	.899 (.561)	.861 (.308)
control variables		
general	.621 (.000)	.599 (.000)
democracy	.810 (.255)	.810 (.251)
semi-democracy	1.607 (.014)	1.570 (.018)
ln GDP per capita[a]	-.618 (.000)	-.654 (.000)
global	26.748 (.000)	24.775 (.000)
regional	10.279 (.000)	9.266 (.000)
independence	3.752 (.000)	4.145 (.000)
labour	1.681 (.000)	1.653 (.000)
mean growth	.988 (.561)	.987 (.523)
ln(sigma)	.812 (.000)	.808 (.000)
log likelihood	-2830.3446	-2838.2279

[a] For ln GDP per capita the raw coefficient is reported which can be interpreted as the percentage change in time till ratification as a result of a one-percent increase in GDP per capita.

6.4 Semi-parametric analysis

Semi-parametric analysis does not make an assumption on the time dependence, only on the impact of the explanatory variables. It assumes that the hazard of one group is always some fixed proportion larger or smaller than the other group(s). This effect of the explanatory variable does not change over time. This assumption is checked in appendix G. The appendix shows that the assumption does not hold for the dummy denoting general treaties, the volume of international trade variable and the democracy and the semi-democracy dummies. The model is corrected by stratifying for these variables. This means that each group (e.g. democracies and dictatorships) has its own hazard function. This way the effect of becoming a democracy can freely change over time. However, no estimates are obtained for the effect of the stratified variables since the effect of these variables is absorbed by the different unspecified hazard functions. This is a pity since these variables represent interesting hypotheses, but not crucial since none of these variables relate to the main question of this paper.[2]

Remember that I hypothesised that international trade could have an effect through three channels. First the size of a country could make the effect of international trade more positive. Second, the non-competitiveness of the regulated industry could make the effect of international trade more negative. Finally, the presence of other important high standard countries could make the effect of international trade more positive.

Table 6.2 shows that the size of countries has no influence on the speed of ratification nor does it make international trade have a more positive effect. The competitiveness of the regulated industry has no direct effect. It does make international trade (measured by the absence of restrictive measures) have a more positive effect. The semi-parametric analysis supports the prediction that the sum of the GDP of the countries that had already ratified has a positive impact on the speed of ratification but it does not support the prediction that this variable makes international trade have a more positive effect. The effect of the openness dummy is insignificant. Removing the interaction terms show that the interaction does not add significantly to the fit of the model (χ^2=8.76 with 6 degrees of freedom). From the control variables only the hypotheses concerning the wealth of the country and the territorial scope of the treaty could be tested. GDP per capita and the regional scope of the treaty, are both significant and have the expected effect, that is rich countries ratify faster and treaties with a small territorial scope are ratified faster. This means that the semi-parametric analysis supports none of the hypothesised effect of international trade. It does support the hypotheses that rich countries ratify faster and that treaties with a small territorial scope are ratified faster.

The robustness of these conclusions where tested by using different variables for the same concepts. The effects of size and international trade could be investigated in this way. The results are presented in appendix H. The appendix shows that semi-parametric analysis provides robust support for the conclusion that none of the hypotheses concerning the impact of international trade are supported.

[2]Not even the volume of international trade since this variable represents only the residual effect of international trade.

Table 6.2: estimates of the semi-parametric model (efron method for ties and stratified by democracy, semi-democracy, general and trade) Reported coefficients are hazard ratios.[a] The level of significance is shown in parentheses.

	with interaction	without interaction
trade related variables		
GDP	1.000 (.329)	.9999 (.019)
GDP*trade	1.000 (.737)	-
GDP*open	1.000 (.053)	-
noncompetitive	.864 (.233)	1.041 (.643)
noncompetitive*trade	.999 (.660)	-
noncompetitive*open	1.394 (.029)	-
sum of GDP	1.111 (.000)	1.113 (.000)
sum of GDP*trade	1.000 (.830)	-
sum of GDP*open	1.001 (.898)	-
open	1.022 (.825)	1.130 (.164)
control variables		
ln GDP per capita[a]	.357 (.000)	.360 (.000)
global	.110 (.000)	.113 (.000)
regional	.171 (.000)	.177 (.000)
independence	.519 (.000)	.505 (.000)
labour	.795 (.005)	.803 (.007)
mean growth	1.003 (.806)	1.007 (.582)
log likelihood	-4384.3926	-4388.7734

[a] For ln GDP per capita the raw coefficient is reported which can be interpreted as the percentage change in the hazard of ratification as a result of a one-percent increase in GDP per capita.

6.5 Conclusions

This chapter intends to find an empirical answer to the main question of this paper: does international trade influence the level of regulation? This is done by testing three predictions derived from the previous chapters. These predictions suggest that international trade can have an impact through three channels:

1. International trade is expected to have a more positive effect on the speed of ratification for large countries, because the prefered level of regulation is more homogenous for large countries than for small countries.
2. International trade is expected to have a more negative effect on the level of regulation when the regulated industry is non-competitive, because subsidising this industry will enable the domestic firms to capture a larger share of the rents in that industry, and low levels of regulation is an attractive way of subsidising an industry.
3. International trade is expected to have a more positive effect on the level of regulation when there are other important countries with higher levels of regulation, because high levels of regulation may be a cheap way for the exporting firms of signalling compliance with the high standards of the importing countries.

To test these hypotheses three techniques where used to analyse the dataset. The conclusions derived from these techniques are shown in tabel 6.3. One model from one technique, the log-normal parametric model, was chosen as the best fitting model. (see appendixes E and G) This model is most likely to elicit the best conclusions from the dataset. The results from the remaining two techniques will be used to assess whether the conclusions are robust. The table shows that this model only found support for channel three. The hypotheses related to international trade are not the only hypotheses that are tested. Four other possible causes of differences in the level of regulation are tested in these models. Their prime purpose is to ensure that the estimates from the trade related hypotheses are reliable, but the results are interesting enough to be mentioned here. Treaties dealing with general issues are ratified faster than treaties dealing with specific industries. I hypothesised that the reason for this is that treaties dealing with general issues face a less strong industry lobby. Furthermore, rich countries ratify faster than poor countries and treaties with a small territorial scope are ratified faster than treaties with a large territorial scope. The only non-trade related hypothesis that was not supported was the hypothesis that democracies ratify faster than dictatorships.

The log-normal parametric model is the best model, but we can be more confident in the conclusions drawn form this model if they do not depend

Table 6.3: conclusions from the best non-parametric, parametric and semi-parametric models

		non-parametric	parametric	semi-parametric
trade related hypotheses				
h1a	Large countries ratify faster.	yes	no	no
h1b	International trade has a more positive effect in large countries.	-	no	no
h2a	Treaties dealing with non-competitive industries are ratified slower.	yes	no	no
h2b	International trade has a more negative effect when the treaty deals with a non-competitive industry.	-	no	no
h3a	Treaties will be ratified faster when the sum of the GDP of the countries that have ratified is large.	-	yes	yes
h3b	International trade has a more positive effect when the sum of the GDP of the countries that have ratified is large.	-	yes	no
hypotheses related to control variables				
h4	Treaties dealing with general issues will be ratified faster than treaties dealing with specific industries.	yes	yes	-
h5	Democracies will ratify faster than semi-democracies and dictatorships	yes	no	-
h6	Rich countries will ratify faster than poor countries.	yes	yes	yes
h7	Treaties with a small territorial scope will be ratified faster than treaties with a large territorial scope.	yes	yes	yes

upon the specific assumptions of this model. The robustness of the conclusions can be assessed in three ways: First, several measures of size, international trade and democracy have been used in the non-parametric, parametric and semiparametric techniques, in order to see whether the conclusions depend on the chosen way of measuring these concepts. Second, two alternative assumptions on how the probability of ratifying changes over time has been used in parametric analysis in order to see whether the conclusions depend upon the chosen assumption. Third the conclusions drawn from the different analysis techniques are compared, in order to see whether the results depend on the chosen technique. The results are summarised in table 6.4. It shows that the support found for hypothis h3b, proofed to be not robust. Furthermore, the conclusions concerning the control variables where all robust except for the effect of democracy.

In short, the main purpose of this paper is to find whether there is a relationship between international trade and the level of regulation. We expected that international trade would have an impact through the size of the country, the competitiveness of the regulated industry and the importance of high standard foreign markets. Moderate support was found for only the last hypothesis, but it not prove to be robust. The first two were clearly rejected. Other aspects like the wealth of the country, the strength of lobbying groups and territorial scope of co-operative efforts between countries have a much more robust impact. This would mean that these other aspects are much more important than international trade, if international trade has any effect at all.

Table 6.4: robustness of the conclusions

		non-parametric	**parametric**		**semi-parametric**	**overall**	
		different variables	different variables	different assumptions time-dependence	different variables	different techniques	overall
trade related hypotheses							
h1a	Large countries ratify faster.	robust	not robust	robust	robust	not robust	not robust
h1b	International trade has a more positive effect in large countries.	-	robust	robust	robust	robust	robust
h2a	Treaties dealing with non-competitive industries are ratified slower.	-	-	not robust	-	not robust	not robust
h2b	International trade has a more negative effect when the treaty deals with a non-competitive industry.	-	robust	robust	robust	robust	robust
h3a	Treaties will be ratified faster when the sum of the GDP of the countries that have ratified is large.	-	-	robust	-	robust	robust
h3b	International trade has a more positive effect when the sum of the GDP of the countries that have ratified is large.	-	not robust	not robust	robust	not robust	not robust
hypotheses related to control variables							
h4	Treaties dealing with general issues will be ratified faster than treaties dealing with specific industries.	-	-	robust	-	robust	robust
h5	Democracies will ratify faster than semi-democracies and dictatorships	robust	robust	robust	-	not robust	not robust
h6	Rich countries will ratify faster than poor countries.	-	-	robust	-	robust	robust
h7	Treaties with a small territorial scope will be ratified faster than treaties with a large territorial scope.	-	-	robust	-	robust	robust

Chapter 7

Conclusions and discussion

7.1 Conclusions

The main question that this paper tries to answer is: Does international trade influence the level of domestic regulation? This question begs immediately a second question: Why would international trade influence the level of domestic regulation? Two types of answers are possible to this question. The first type assumes that the level of regulation approaches the optimal level, and that international trade changes this optimal level. International trade can change the optimal level of regulation because international trade will change the price of the goods, including the goods that are sacrificed by implementing the regulation. So an exporting country will experience an increase in prices and thus a increase in the cost of regulation and thus a decrease in the level of regulation. Similarly, an importing country will experience a decrease in prices, and thus a decrease in the cost of regulation and thus an increase in the level of regulation.

The second type of answer assumes that international trade leads politicians to choose a level of regulation that deviates from the optimal level. This paper discussed four channels through which international trade could lead to a deviation from the optimal level of regulation. Firstly, international trade might have a positive effect on the speed of ratification when a country is so large that it can influence world prices. In that case a country can use that fact to decrease the price of its imports by allowing a larger than efficient amount production or increase the price of its exports by allowing a less than efficient amount of production. This effect thus counteracts the effect of international trade on the optimal level of regulation. That means that regulations will be more homogenous for large countries than for small countries. Large countries are predicted to ratify faster than smaller countries, since many treaties have homogenising characteristics. It also means that size will make openness have a positive effect on the speed of ratification, since this effect works because of international trade. However, these hypotheses were not confirmed by the data.

Secondly, international trade might have a negative impact on the level of regulation when the regulated industry is non-competitive. In this case it becomes attractive to subsidise this industry, since this will increase the share the domestic firms can grab of the rents earned in this industry. A low level of regulation is one way of subsidising an industry. Treaties dealing with competitive industries are thus expected to be ratified faster than treaties dealing with non-competitive industries. The rents have to be grabed from abroad through international trade, so we expect that the non-competitiveness of regulated firms result in international trade having a negative effect on the speed of ratification. Again these hypotheses were not supported by the data.

Thirdly, international trade can have a positive impact on the speed of ratification when important other countries have higher levels of regulation because it may be difficult to export to such a country. The consumers may want high standard goods or the firms of the importing country may resent having to compete with low standard goods and demand a 'level playing field'. Increasing the level of regulation in the exporting country might be a cheap way of signalling compliance with importing countries preferences or standards. So, the larger the joint GDP of all countries that have ratified the treaty, the faster the remaining countries will ratify, and a large joint GDP is expected to make the effect of international trade more positive. These effects where found in the best fitting model, but did not prove to be robust.

Finally, international trade can have a negative influence on the level of regulation when relocating resources between industries is costly. Increased regulation may cause an industry to leave a country and thus necessitate a relocation of resources to another industry. The moving away of an industry is in itself not a problem, it is just a way of making the best use of the given resources and preferences for regulation. This may however cause short-term costs like unemployment if the moving of resources between industries is costly. This effect was however not tested since no satisfactory measure of the cost of relocating resources was found.

In order to estimate the parametric and semi-parametric models it was necessary to control for other factors that might influence the level of regulation. Although these other factors have no direct bearing on the main question of this paper, the results are interesting enough to be mentioned here. First, treaties dealing with specific industries were predicted to be ratified more slowly than general treaties because specific industries are more likely to be able to organise an effective lobby than the entire business community. This hypothesis was supported by the data. Second, democratic countries were expected to ratify faster than semi-democracies and dictatorships, since dictators get a larger share of the production decrease caused by regulation and they have alternative means of diverting the effects of externalities away from them. This effect was however not found. Third, the richer countries were predicted to ratify faster, since demand for strong labour and environmental standards are likely to increase with income. This hypothesis was clearly supported by the data. Finally, more local treaties where expected to be ratified faster than more global treaties, both because countries where expected to value the opinion of their neighbours more highly than that of the 'world community' and because small groups of countries are more likely to overcome co-operation problems than large groups. This prediction was again supported by the data. All supported hypotheses were robust.

In short, I hypothesised that international trade might have an impact through five mechanisms and three of these were tested. Some evidence has been found for the hypothesis that international trade has a more positive effect when large other countries have higher levels of regulation, but this support did not prove to be robust. No evidence was found for the hypotheses that international trade might have a negative effect for regulations dealing with non-competitive industries and that the size of countries might speed up ratification. Much more robust support was found for hypotheses that had nothing to do with international trade. These are the hypotheses that rich countries have higher levels of regulation, that regulations dealing with specific industries are less stringent that general regulations and that local co-operation is much more likely than regional or global co-operation. This would suggest that these other explanations of the level of regulation are much more important than international trade.

7.2 Discussion

Any study will have a number of strong points and a number of weak points. This study contains two important strong points compared to previous studies in this area. The first one is that this study explicitly tests different mechanisms through which international trade could influence the level of regulation. This is important since international trade can sometimes have a positive effect and sometimes a negative effect. These positive and negative effects will (partially) cancel each other out when one does not explicitly distinguish between these different mechanisms. Previous studies just tested the net effect of international trade. This could explain why they did not find an effect of international trade. The second strong point of this study is that a relatively large number of treaties where analysed simultaneously which covered a longer time period. This way the idiosyncrasies of individual treaties or periods will become less influential. A second advantage of simultaneous analysis of multiple treaties is that it allows the testing of the effects of characteristics of treaties (e.g. whether a treaty deals with a competitive or non-competitive industry). Previous studies just analysed one treaty or a small number of treaties separately and limited their study to the 90's. The fact that despite these improvements only a limited influence of international trade was found strengthened the finding of the previous studies that international trade does not have a major impact on the level of regulation.

This study also has a number of points, which could be improved upon in future studies. First, the speed of ratification is a rather indirect way of measuring the level of regulation. Although this measure is quite defensible, one could have even more confidence in the results when they are reproduced by a another study, which uses a different measure of the level of regulation.[1] The measure of the level of environmental regulation proposed by Dasgupta *et al.* (2001) looks promising in this respect. Second, two mechanisms through which international trade could influence the level of regulation are not measured in this study. These are the effect of international trade through the optimal level of regulation and through the costs of relocating resources between industries. The data necessary for measuring the first effect is available for a smaller set of countries and for a shorter period than was used in this study. However, measuring this effect may be well worth the loss in the number of cases.[2] Third, the effect of important countries with higher standards was measured in a way that did not take the strength of the relationship between the countries into account. For instance, Great Britain and India have approximately the same GDP[3]. So, the effect of ratification by Great Britain on the Netherlands should, according the statistical model, be the same as the effect of ratifcation by India on the Netherlands. However, Great Britain is a much more important trading partner for the Netherland than India is. (The value of international trade between the Netherland and Great Britain in 1992 was 28 billion US dollars while the value of international trade between the Netherlands and India in 1992 was 0.65 billion US dollars (Barbieri 2001).) A possible solution to this problem is to apply weights based upon the bilateral trade when calculating the sum of GDP of all countries that have ratified. An alternative approach, which focusses more on bilateral preasures, would use dyads (pairs of countries) and through multinomial logistic regression estimate the different effects of international trade between the two countries on

[1] A different measure for the level of regulation may be particularly useful when one is also interested in the effects of the political variables. Political variables (like the level of democracy) influence the speed of ratification because they influence the level of regulation but also because they influence the speed at which decisions are made. A more direct measure of the level of regulation will eliminate this contamination.

[2] Especially since it will also allow a more direct measurement of the effect of size. Remember that size is expected to counteract the effect of international trade on the optimal level of regulation.

[3] India is clearly poorer than Great Britain but India has a much larger population and these effects cancel each other out.

the probabilities that both countries have ratified, country one has ratified while country two has not ratified, country one has not ratified while country two has ratified and both countries have not ratified.

In short, there are three ways in which a future study could improve this study. Firstly, it could use a different measure of the level of regulation. The time till ratification is a defensible measure for the level of regulation, but it is a key variable and the confidence in the results would be improved if they where replicated in a study using a different measure. Secondly, a future study could improve this study by also measuring the effect of international trade through its effect on the optimal level of regulation or through the costs of relocating resources between industries. Thirdly, the strength of the relationship between countries could be taken into account when measuring the effect of international trade through important countries with higher standards. However, this study is also improvement on previous empirical studies. First, it differentiates between different channels through which international trade could have an influence. That way it prevents that no impact of international trade is found because the different channels cancel each other out. Second, it uses data on multiple treaties and spans a larger period of time, thus making the idiosyncrasies of individual treaties and periods less influential.

Appendix A

Treaties

Nr	Treaty name	Date of addoption	Area[a]	Labour [b]	Non-competitive[c]	Specific industry[d]	Delete land-locked[e]
1	Convention concerning Minimum Wage Fixing Machinery in Agriculture	28-06-‘51	G	L		S	
2	Convention concerning the Minimum Age for Admission to Employment as Fishermen	19-06-’59	G	L		S	D
3	Convention concerning Wages, Hours of Work on Board Ship and Manning	14-05-‘58	G	L	N	S	D
4	Protocol to the Convention concerning Conditions of Employment of Plantation Workers	24-06-‘58	G	L	N	S	
5	Convention concerning Equal Remuneration for Men and Women Workers for Work of Equal Value	29-06-‘51	G	L			
6	Convention concerning Weekly Rest in Commerce and Offices	26-06-‘57	G	L			
7	Convention concerning Accommodation on Board Fishing Vessels	21-06-‘66	G	L		S	D
8	Convention concerning Labour Inspection in Agriculture	25-06-‘69	G	L		S	
9	Convention concerning the Minimum Age for Admission to Employment Underground in Mines	22-06-‘65	G	L	N	S	
10	Convention concerning Basic Aims and Standards of Social Policy	22-06-‘62	G	L			
11	Convention concerning the Guarding of Machinery	25-06-‘63	G	L			
12	Convention concerning the Social Repercussions of New Methods of Cargo Handling in Docks	25-06-‘73	G	L		S	
13	Convention concerning Hours of Work and Rest Periods in Road Transport	27-06-‘79	G	L		S	
14	Convention concerning Protection against Hazards of Poisoning Arising from Benzene	23-06-‘71	G	L	N	S	
15	Convention concerning Minimum Standards in Merchant Ships	29-10-‘76	G	L	N	S	D
16	Convention concerning Minimum Wage Fixing, with Special Reference to Developing Countries	22-06-‘70	G	L			
17	Convention concerning Protection and Facilities to be Afforded to Workers’ Representatives in the Undertaking	23-06-‘71	G	L			

Nr	Treaty name	Date of addoption	Area[a]	Labour [b]	Non-competitive[c]	Specific industry[d]	Delete land-locked[e]
18	Protocol to the International Convention for the Regulation of Whaling	19-11-'56	G	E		S	
19	Convention on Fishing and Conservation of the Living Resources of the High Seas	29-04-'58	G	E		S	
20	International Convention for the Prevention of Pollution of the Sea by Oil ,1954, as amended in 1962 and 1969	05-12-'54	G	E	N	S	
21	The Antarctic Treaty	01-12-'59	G	E			
22	International Convention on Civil Liability for Oil Pollution Damage	29-11-'69	G	E	N	S	
23	Convention on International Trade in Endangered Species of Wild Fauna and Flora	03-03-'73	G	E		S	
24	Amendments to the International Convention for the Prevention of Pollution of the Sea by Oil ,1954, concerning Tank Arrangements and Limitation of Tank Size	15-10-'71	G	E	N	S	
25	International Convention for the Prevention of Pollution from Ships (MARPOL) - Annex V (Optional) = Garbage	02-11-'73	G	E	N	S	
26	Convention on Wetlands of International Importance especially as Waterfowl Habitat	02-02-'71	G	E			
27	Convention on the Conservation of Migratory Species of Wild Animals	23-06-'79	G	E			
28	European Agreement concerning the International Carriage of Dangerous Goods by Road	30-09-'57	R	E		S	
29	North-East Atlantic Fisheries Convention	24-01-'59	R	E		S	
30	Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts	20-03-'58	R	E	N	S	
31	International Convention for the Protection of Birds	18-10-'50	R	E			
32	International Convention for the Conservation of Atlantic Tunas	14-05-'66	R	E		S	

Nr	Treaty name	Date of addoption	Area[a]	Labour [b]	Non-competitive[c]	Specific industry[d]	Delete land-locked[e]
33	Convention on Conduct of Fishing Operations in the North Atlantic	01-06-‘67	R	E		S	
34	Agreed Measures for the Conservation of Antarctic Fauna and Flora	02-06-‘64	R	E			
35	African Convention on the Conservation of Nature and Natural Resources	15-09-‘68	R	E			
36	Protocol amending the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)	21-08-‘75	R	E		S	
37	Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency	16-02-‘76	R	E	N	S	
38	Treaty for Amazonian Co-operation	03-07-‘78	L	E			
39	Convention on Long-Range Transboundary Air Pollution	13-11-‘79	R	E			
39	Convention on Long-Range Transboundary Air Pollution	13-11-‘79	R	E			
40	Agreement concerning Measures for the Protection of the Stocks of Deep Sea Prawns (Pandalus Borealis), European Lobsters (Homarus Vulgaris), Norway lobsters (Nephrops Norvegicus) and Crabs (Cancer Pagurus)	07-03-‘52	L	E		S	
41	Agreement on the Protection of the Salmon in the Baltic Sea	20-12-‘62	L	E		S	
42	Agreement concerning the International Commission for the Protection of the Rhine against Pollution	29-0 4-‘63	L	E			
43	Agreement on Conservation of Polar Bears	15-11-‘73	L	E			
44	Convention for the Protection of the Rhine against Chemical Pollution	03-12-‘76	L	E	N	S	
45	Convention on Conservation of Nature in the South Pacific	12-06-‘76	L	E			

[a] G = Global, R = Regional, L = Local
[b] L = Labour, E = Environment
[c] N = Noncompetitive, blanc = otherwise
[d] S = Specific industry, blanc = otherwise
[e] D = Land-locked countries deleted, blanc = otherwise
[a] G = Global, R = Regional, L = Local
[b] L = Labour, E = Environment
[c] N = Noncompetitive, blanc = otherwise
[d] S = Specific industry, blanc = otherwise
[e] D = Land-locked countries deleted, blanc = otherwise

Appendix B

Countries

country	treaties (numbers refer to appendix A)
Algeria	2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35, 37,
Angola	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Argentina	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34,
Australia	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 34, 45
Austria	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 34, 36, 39,
Bangladesh	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Belgium	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 39,
Benin	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Bolivia	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 38,
Botswana	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Brazil	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34, 38,
Burkina Faso	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Burundi	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Cameroun	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Canada	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 33, 34, 39, 43,
Central African Republic	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Chad	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Chile	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34,
China	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34,
Colombia	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34, 38,
Congo	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Costa Rica	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Cyprus	1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36, 37, 39,
Denmark	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 39, 40, 41, 43,
Dominican Republic	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Ecuador	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 34, 38,

country	treaties (numbers refer to appendix A)
Egypt	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35, 37,
El Salvador	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Ethiopia	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Finland	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 39, 41,
France	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 37, 38, 39, 42, 44, 45
Gabon	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Gambia	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
German Federal Republic	1, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33, 34, 36, 39
Ghana	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Greece	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 37, 39
Guatemala	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Guinea	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Guinea-Bissau	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Guyana	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 38,
Haiti	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Honduras	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Hungary	4, 6, 8, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 31, 34, 36, 39
India	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 34,
Indonesia	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Iran	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Ireland	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36, 39
Israel	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 37,
Italy	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 37, 39
Ivory Coast	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Jamaica	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Japan	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34,

country	treaties (numbers refer to appendix A)
Jordan	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Kenya	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Korea,South	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34,
Malagasy Republic	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Malawi	4, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Malaysia	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27,
Mali	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Mauritania	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Mauritius	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Mexico	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Morocco	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35, 37,
Mozambique	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Nepal	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Netherlands	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 39, 42, 44,
New Zealand	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 34, 45
Nicaragua	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Niger	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Nigeria	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Norway	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 39, 40, 43,
Pakistan	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Papua New Guinea	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 34, 45
Paraguay	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Peru	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 34,
Philippines	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Poland	1, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32, 33, 34, 36, 39, 41,
Portugal	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 36, 39,

country	treaties (numbers refer to appendix A)
Republic of China	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Rwanda	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Senegal	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Sierra Leone	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Singapore	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
South Africa	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34, 35,
Spain	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 39,
Sri Lanka	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Sweden	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 39, 40, 41,
Switzerland	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 34, 36, 39, 42, 44
Syria	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35, 37,
Tanzania	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Thailand	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
Togo	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Trinidad and Tobago	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32,
Tunisia	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35, 37,
Turkey	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 30, 31, 32, 37, 39,
Uganda	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
United Kingdom	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 39, 45
United States of America	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 33, 34, 39, 43,
Uruguay	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 34,
Venezuela	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 38,
Yemen Arab Republic	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 21, 23, 24, 25, 26, 27,
Zaire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 32, 35,
Zambia	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,
Zimbabwe	1, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 35,

Appendix C

Variables

				predictions on		
variable	description	hypothesis	theoretical concept	survival curves	hazard ratios	time ratios
GDP	Total GDP (not GDP per capita) in milliards (10^{12}) of 1996 dollars	H1a	size of country	large countries below small countries	>1	<1
GDP*current trade	interaction term with the current trade variable	H1b	impact of size on the effect of international trade	-	>1	<1
GDP*constant trade	interaction term with the constant trade variable	H1b	impact of size on the effect of international trade	-	>1	<1
GDP*open	interaction term with the openness variable	H1b	impact of size on the effect of international trade	-	>1	<1
population	population in millions	H1a	size of country	large countries below small countries	>1	<1
population* current trade	interaction term with the current trade variable	H1b	impact of size on the effect of international trade	-	>1	<1
population* constant trade	interaction term with the constant trade variable	H1b	impact of size on the effect of international trade	-	>1	<1
population*open	interaction term with the openness variable	H1b	impact of size on the effect of international trade	-	>1	<1

				predictions on		
variable	description	hypothesis	theoretical concept	survival curves	hazard ratios	time ratios
G7	G7-membership (1= member, 0 = not member)	H1a	size of country	large countries below small countries	>1	<1
G7*current trade	interaction term with the current trade variable	H1b	impact of size on the effect of international trade	-	>1	<1
G7*constant trade	interaction term with the constant trade variable	H1b	impact of size on the effect of international trade	-	>1	<1
G7*open	interaction term with the openness variable	H1b	impact of size on the effect of international trade	-	>1	<1
noncompetitive	treaty dealing with non-competitive industry (1= non-competitive industry, 0 = either competitive industry or general treaty)	H2a	competitiveness of regulated industry	non-competitive above competitive	<1	>1
noncompetitive * current trade	interaction term with the trade variable	H2b	impact of the competitiveness of regulated industry on the effect of international trade	-	<1	>1
noncompetitive * constant trade	interaction term with the trade variable	H2b	impact of the competitiveness of regulated industry on the effect of international trade	-	<1	>1

				predictions on		
variable	description	hypothesis	theoretical concept	survival curves	hazard ratios	time ratios
noncompetitive * open	interaction term with the openness variable	H2b	impact of the competitiveness of regulated industry on the effect of international trade	-	<1	>1
sum of GDP	The sum of GDP of all countries that have ratified the treaty in trillions (10^{15}) of 1992 dollars	H3a	importance of high standard countries	-	>1	<1
sum of GDP * current trade	interaction term with the current trade variable	H3b	impact of the importance of high standard countries on the effect of international trade	-	>1	<1
sum of GDP * constant trade	interaction term with the constant trade variable	H3b	impact of the importance of high standard countries on the effect of international trade	-	>1	<1
sum of GDP * open	interaction term with the openness variable	H3b	impact of the importance of high standard countries on the effect of international trade	-	>1	<1
general	treaty dealing with general issue (1 = general treaty, 0 = specific industry, either competitive or noncompetitive)	H4	power of business lobby	general treaties below specific treaties	>1	<1

				predictions on		
variable	description	hypothesis	theoretical concept	survival curves	hazard ratios	time ratios
democracy Polity IV	democracy according to Polity IV dataset (1= democracy, 0= other)	H5	level of democracy	democracy under semi-democracy and dictatorship	>1	<1
semi-democracy Polity IV	semi-democracy according to Polity IV dataset (1= semi-democracy, 0= other)		level of democracy	-	-	-
democracy Vanhanen	democracy according to Vanhanen dataset (1= democracy, 0= other)	H5	level of democracy	democracy under semi-democracy and dictatorship	>1	<1
semi-democracy Vanhanen	semi-democracy according to Vanhanen dataset (1= semi-democracy, 0= other)		level of democracy	-	-	-
ln GDP per capita	logarithm of GDP per capita in 1992 dollars	H6	wealth of country	rich countries under poor countries	raw parameter > 0	raw parameter < 0
global	global treaty (1= global treaty, 0 = other)	H7	territorial scope of treaty	global treaties above regional treaties	<1	>1
regional	regional treaty (1= regional treaty, 0 = other)	H7	territorial scope of treaty	regional treaties above local treaties	<1	>1

				predictions on		
variable	description	hypothesis	theoretical concept	survival curves	hazard ratios	time ratios
current trade	international trade relative to GDP (imports + exports /GDP *100) in current prices	control	-	-	-	-
constant trade	international trade relative to GDP (imports + exports /GDP *100) in constant prices	control	-	-	-	-
open	dummy denoting the absence of restrictive measures (0 = closed, 1 = open)	control	-	-	-	-
mean growth	mean growth of GDP per capita in the past five years	control	-	-	-	-
independence	time starts with independence (1 = time starts with independence of country, 0 = time starts with begin of treaty)	control	-	-	-	-
labour	labour or environmental treaty (1= labour treaty, 0 = environmental treaty)	control	-	-	-	-

Appendix D

Method

D.1 Introduction

This section discusses the techniques used in the analysis of the data. The set of techniques used in the analysis is called survival analysis. Other names for these techniques are event history analysis, duration analysis or transition analysis. The techniques all assume that the observed durations are realisations of some random process. We may think of this as countries that every year run a "risk"[1] of ratifying that year. We would expect that the duration is short when this risk is high and long when the risk is low. That risk of ratifying may change from year to year or may be different for countries with different characteristics. These characteristics can be the explanatory variables. With survival analysis we can estimate the impact of the explanatory variables on the risk of ratifying. Three techniques will be discussed: the non-parametric, the parametric and the semi-parametric.

D.2 Probability distributions

The risk of ratifying needs to be more specificaly defined before the impact of explanatory variables on the risk of ratifying can be discussed. The risk of ratifying is a probability. For instance: the probability that a country takes longer then 5 years to ratify, or the probability that a country ratifies the treaty after exactly 11 years. These probabilities are of course interrelated. In fact, both require the analysis of the same frequency distribution. The different probabilities will thus reflect different representations of the same stochastic variable. Survival analysis estimates the probability of ratifying

[1] The word risk is used here because this is the common terminology in survival analysis. Many of the terms are derived from the application of these techniques in medical science where it is used to explain how long patients live after getting a certain illness or receiving a certain treatment. This explains the negative or positive connotations of many of the terms used in survival analysis.

Table D.1: example

country	duration
West-Germany	3
Netherlands	7
Canada	12
India	13
USA	15
Thailand	15
USSR	16
Brazil	17
UK	19
Niger	20

and how it changes over time and for different values of the explanatory variables. The set of probabilities of ratifying for every possible duration is the probability distribution. So, the way the probability of ratifying changes over time is captured by the probability distribution. Every probability distribution can be presented in several different ways; for instance the probability that ratification takes longer than some specified amount of time or the probability that ratification occurs at some specified point in time. This can best be explained by using an example. This example will consist of ten countries that are eligible to ratify a treaty. For the moment we assume that all countries have ratified the treaty before the end of the study (that is, there is no right censoring). They are presented in table D.1.

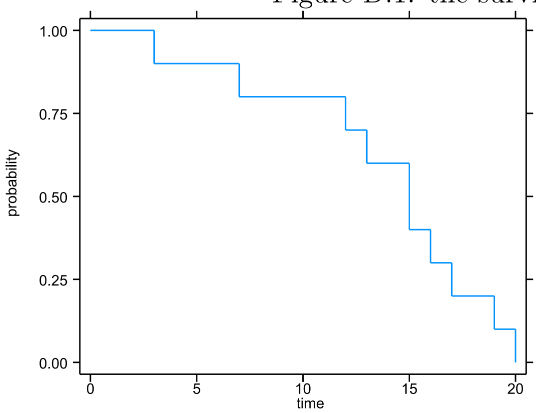
These durations are assumed to be the result of a random process, and we want to summarise the probability distribution that underlies this process. The first way to present the probability distribution is obtained by looking at the probability that ratification takes longer than some specified duration. Table D.2 presents what happens at different points in time. If we want to know what the probability is that ratification takes longer than 3 years, than all we have to do is look at the number of countries that have "survived" (i.e. not ratified) after 3 years and divide that by the total number of countries. After three years nine countries survived and the total number of countries is ten, so the probability of surviving after three years is 90%. If all these probabilities are graphed against time, as is done in figure D.1, than we get the survivor function, S(t).

This Survivor function has three notable features: the first feature is that the graph starts at 1. The reason for this is that at the moment that the country is first able to ratify the treaty (t = 0) its probability of not having done so before is by definition equal to 1. The second feature is that the graph does not rise. The reason for this is that those countries who run a risk of not ratifying at t = 20 must not have ratified at t= 10. Consequently

Table D.2: the survivor function

time	no. countries not ratified	S(t)
0	10	10/10=1
3	9	9/10
7	8	8/10
12	7	7/10
13	6	6/10
15	4	4/10
16	3	3/10
17	2	2/10
19	1	1/10
20	0	1/10=0

Figure D.1: the survivor function



the probability of not ratifying at t = 20 can not exceed the probability of not ratifying at t=10. The third feature is that the graph is a step-function. This does not mean that we believe that the 'real' survivor function has this shape, far from it. All that it means is that this is, given our data, our best estimate of the survivor function. For example, the probability of surviving after five years is the same as the probability of surviving after three years or four years or six years: nine out of ten countries survived, so the probability of surviving is 90% for all these durations.

The survivor function is closely related to another way of representing the same distribution that is commonly used in other statistical techniques, the cumulative probability function (F(t)). The cumulative probability function gives for every time t the probability that the duration is less or equal to t. The survivor function must be the complement to one of the cumulative probability function, since the probability that a country ratifies before, on or after t is necessarily 1 (we assume that all countries will eventually ratify so there are no other possibilities). So the relationship between the survivor function and the cumulative probability function is: S(t) = 1 - F(t). The cumulative probability function is closely related to another way of presenting the probability distribution: the probability density function, f(t). The probability density function is the first derivative of the cumulative probability function. The familiar bell shaped curve of the normal distribution is a probability density function. For a given interval the surface underneath the curve gives the probability that the time it takes to ratify the treaty falls within that interval. Alternatively, it can be thought of as the instantaneous probability of ratifying at time t. The fourth way of representing the probability distribution looks at the probability of ratifying at time t for countries that have not yet ratified, since the countries that have already ratified are clearly no longer at risk of ratifying and the probability density function does not take this into account. So we want to know the probability of ratification conditional on the country surviving to time t. The probability of surviving to time t is the survivor function, as was shown before. We can make the probability conditional on having survived to time t by dividing the probability density function by the survivor function. This is called the hazard function. This measure comes closer to the notion of the instantaneous probability of ratifying than the probability density function. However, the hazard is strictly speaking not a probability. For one thing, the real instantaneous probability of ratifying is necessarily zero.[2] A more correct interpretation of the hazard is the number of times a country would be expected to ratify if the risk of ratifying would remain constant for one unit of time. So if a hazard of 0.1 is found and time is measured in months than

[2]Time is a continuous variable. Being a continuous variable means that time can take an infinite number of specific values. The probability that a continuous variable takes on any one specific value is one divided by infinity, and that is zero.

a country will on average ratify 0.1 times in the next month if the hazard remains constant during that month. Still, this is close enough to continue with the interpretation of the hazard as the instantaneous probability of ratifying.

To sum up, we are interested in the probability of ratifying at every point in time (and in how these probabilities differ for different kinds of countries, but this will be discussed later in this appendix). The set of probabilities of ratifying at every point in time is the probability distribution. Four different ways of presenting the probability distribution have been discussed. The first way is the survival function. This gives at every point in time the probability that ratification takes longer then that point in time. The second way is the cumulative probability function. This gives for every point in time the probability that ratification takes less then that point in time. The third way is the probability density function. This gives for every point in time the probability that ratification occurs on that point in time, only it does not take into account that those countries that have already ratified before are no longer at risk of ratifying. The fourth way, the hazard function, takes care of this omission. It gives for every point in time the probability that ratification occurs on that point in time if the countries has not ratified before.

D.3 Non-parametric analysis[3]

Several ways of presenting a distribution have been discussed in the previous paragraph. Now it is time to investigate how these can be estimated. Estimating the distribution of the dependent variable without making assumptions about its shape is an important first step in analysing a dataset. Given the importance of the distribution of the dependent variable it is valuable to "let the data speak for itself" first. Estimating the probabilities without making any assumptions on its shape is called non-parametric analysis. The function used to represent the distribution is the Survivor function. Remember that the Survivor function gives the probability that ratifying takes longer than a certain period of time. The example in table D.2 and figure D.1 gives the way to estimate the survivor function when there are no censored observations. The survivor function was calculated by dividing the number of survivors by the total number of countries for every time. A censored observation is a country that has not yet ratified at the time the study ended. The reason why the method of the previous paragraph does not work when there are censored observation is best explained by extending our previous example. This extension is presented in table D.3. We now assume that India, Thailand, the USSR, the UK and Niger are censored. This is indicated by the value zero for the variable ratified. So we know that India

[3]this paragraph relies heavily on (Cleves et al. 2002, chapter 8)

Table D.3: example with censored observations

country	duration	ratified
West-Germany	3	1
Netherlands	7	1
Canada	12	1
India	13	0
USA	15	1
Thailand	16	1
USSR	16	0
Brazil	17	1
UK	19	0
Niger	20	0

has not ratified before t=13, but we do not know when India will ratify. Suppose that the survivor function of the dataset presented in table 3 has to be calculated. If we wanted to calculate the probability of survival past for example t=15 we would run into trouble. We know for certain that four countries have ratified and five countries have not ratified at t=15. However we do not know whether India has ratified by then. All we know about India is that India has taken longer then 13 years to ratify. If India ratified at t=14 then the probability of survival past t=15 would be 4/10, if India ratified at say t=16 then the probability of survival past t=15 would be 5/10. Since we do not know when India actually ratified we do not know which of these two to choose. So the method used in the previous paragraph of estimating the survivor function by calculating the proportion of countries that have not yet ratified does not work when some of the observations are censored, since there are times when we do not know whether the censored observations have ratified or not.

The table D.4 summarises what happens at each point in time in the data. At time t=3 all the ten countries were at risk of ratifying, but at that instant only one failed (West Germany). At the next time, t=7, nine countries were at risk of ratifying, and that time one of the nine ratified (the Netherlands). At time = 13 one country, India, was censored while no country ratified. After that time India was no longer at risk of being observed to be ratified, so the number of countries at risk after time = 13 is reduced by one.

The technique used to estimate the survivor function when censoring is present is called the Kaplan-Meier or the product-limit estimator. It uses the principle that although the probability of surviving past t=15 cannot be directly calculated by dividing the number of survivors with the total number of countries, we can calculate the probability of surviving the interval t=13 till t=15. During this interval there were six countries at risk of ratifying of

Table D.4: the events at each point in time

time	no. at risk	no. ratified	no. censored
3	10	1	0
7	9	1	0
12	8	1	0
13	7	0	1
15	6	1	0
16	5	1	1
17	3	1	0
19	2	0	1
20	1	0	1

which one ratified, so the probability of surviving that interval is 5/6. We can think of time as a number of intervals between every point in time that at least one country either ratified or censored. The probability of surviving all such interval can be calculated. For instance:

- The probability of surviving (not ratifying) the interval t=0 till t=3 is 9/10, since nine out of ten countries survived beyond this interval.
- The probability of surviving the interval t=12 till t=13 is 7/7=1, since seven countries were at risk during this interval, of which none ratified. All that happens is that the number of countries at risk after t = 13 is reduced by one.
- The probability of surviving the interval t=15 till t=16 is a bit more difficult. At the end of this interval one country ratified (Thailand) and one country censored (USSR). In order to know the number of countries at risk, we have to make an assumption as to whether the country that censored at time t= 10 was still at risk of ratifying at that time. It is common to assume that censoring occurs just a little bit later than ratifying, so that the USSR (the censored country) is still at risk when Thailand ratified. This means that six countries were at risk, and one ratified. As a result the probability is estimated at 5/6.

And so on. These probabilities (calling them p) are added to the table D.5.

These probabilities can be used to calculate the survival function. The survival function gives the probability of surviving past every point in time. For instance, the probability of surviving past t= 7 equals the probability of surviving the intervals t=0 till t=3 and t=3 till t=7. This is the product of the probabilities of surviving each interval, that is 9/10*8/9=4/5. Similarly, the probability of surviving past t=12 equals the probability of surviving the intervals t=0 till t=3, t=3 till t=7 and t=7 till t=12, that is 9/10*8/9*7/8=7/10. Thus, the estimate of the Survival function is the

Table D.5: probability of surviving interval

interval	no. at risk	no. ratified	no. censored	p
0-3	10	1	0	9/10
3-7	9	1	0	8/9
7-12	8	1	0	7/8
12-13	7	0	1	7/7=1
13-15	6	1	1	5/6
15-16	4	0	1	5/5=1
16-17	3	1	0	2/3
17-19	2	0	1	2/2=1
19-20	1	0	1	1/1=1

Table D.6: the Kaplan Meier survivor function

interval	no. at risk	no. ratified	no. censored	p	$\widehat{S}(t)$
0-3	10	1	0	9/10	9/10
3-7	9	1	0	8/9	9/10*8/9=4/5
7-12	8	1	0	7/8	9/10*8/9*7/8=7/10
12-13	7	0	1	7/7=1	9/10*8/9*7/8*1=7/10
13-15	6	1	1	5/6	9/10*8/9*7/8*1*5/6=7/12
15-16	4	0	1	5/5=1	9/10*8/9*7/8*1*5/6*1=7/12
16-17	3	1	0	2/3	9/10*8/9*7/8*1*5/6*1*2/3=7/18
17-19	2	0	1	2/2=1	9/10*8/9*7/8*1*5/6*1*2/3*1=7/18
19-20	1	0	1	1/1=1	9/10*8/9*7/8*1*5/6*1*2/3*1*1=7/18

running product of the probabilities of surviving the constituent intervals. This can be added to the table, which is done in table D.6 where its called $\widehat{S}(t)$, or graphed as is done in figure D.2. The red ticks in the graphs mark the times when an observation was censored.

This method can easily be extended to compare two groups within the dataset, for instance rich and poor countries. In that case one would calculate separate survivor functions for both groups and graph them. This can be illustrated by extending our example. In table D.7 the dataset is split between rich and poor countries. In table D.8 the survival functions are calculated using the same method as before, only now different survival functions are calculated for the different groups. These survival functions are shown in figure D.3.

If being a rich or a poor country has no influence on the probability of ratifying than the graphs should be more or less equal. If rich countries run a higher risk of ratifying than the risk of surviving (not having ratified) a certain period of time should be lower for rich countries than for pour countries. This means that the survivor function of rich countries should be

Figure D.2: Kaplan-Meier survivor function

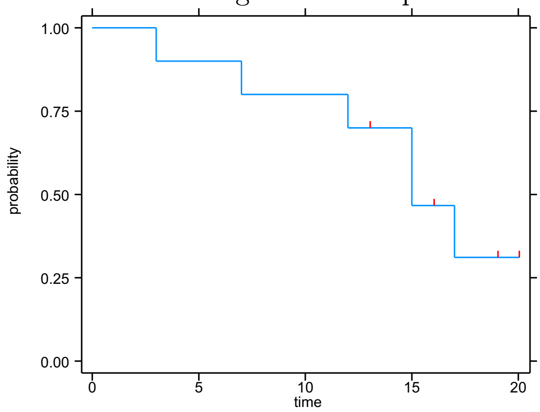


Table D.7: multiple groups

	country	duration	ratified
rich countries			
	West-Germany	3	1
	Netherlands	7	1
	Canada	12	1
	USA	15	1
	UK	19	0
poor countries			
	India	13	0
	Thailand	16	1
	USSR	16	0
	Brazil	17	1
	Niger	20	0

Figure D.3: Kaplan-Meier Survivor curve in case of multiple groups

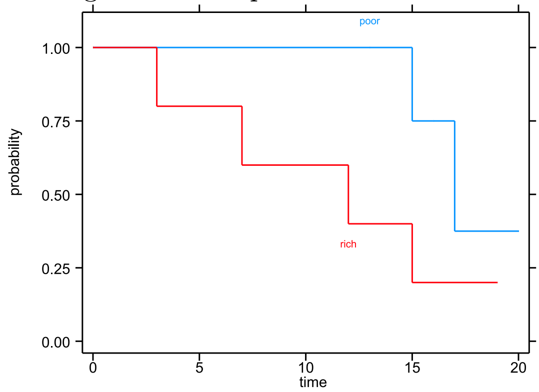


Table D.8: Kaplan-Meier survivor curve in case of multiple groups

time	no. at risk	no. ratified	no. censored	p	$\widehat{S}(t)$
rich countries					
3	5	1	0	4/5	4/5
7	4	1	0	3/4	4/5*3/4=3/5
12	3	1	0	2/3	4/5*3/4*2/3=2/5
15	2	1	0	1/2	4/5*3/4*2/3*1/2=1/5
19	1	0	1	1/1=1	4/5*3/4*2/3*1/2*1=1/5
poor countries					
13	5	0	1	5/5=1	1
16	4	1	1	3/4	1/3/4=3/4
17	2	1	0	1/2	1*3/4*1/2=3/8
20	1	0	1	1/1=1	1*3/4*1/2*1=3/8

below the survivor function of the poor countries. This is exactly what we see in figure D.3. According to this (fictional) dataset rich countries are likely to ratify faster than poor countries. However each group consists of only five countries, so it could be just coincidence that the slow countries are in the poor group and the fast countries in the rich group. (This is of course still true when the dataset is larger; it will only be less likely). To test whether the observed difference is genuine or just coincidence we want to find the probability of observing the data we have observed if we assume that the two groups are the same. The probability is called the level of significance and the assumption the null hypothesis. If the level of significance is very low than the assumption that the two groups are equal is very unlikely and we will have to reject the null hypothesis that the two groups are the same. A commonly used cut-point to decide whether the observed difference is the result of the difference between the groups or coincidence is 5%. A much used test for the difference between survival functions is the log rank test which uses the difference between the total number of countries that can be expected to ratify if the groups are equal and the total number of countries that actually ratify. A Chi square statistic is calculated by dividing the square of this number by the estimated variance. This statistic is then used to calculate the probability of observing the data if the groups were equal, in other words the level of significance. A variation on this test is the Wilcoxon test which uses a weighted difference of the expected total number of ratifications and the actual number of ratifications. The log rank test is more sensitive to differences at later points in time, while the Wilcoxon test is more sensitive in the beginning. The level of significance received from the log rank test for our example data is 11.7%, while the level of significance received from the Wilcoxon test is 4.8%. This would suggest that the observed difference between rich and poor countries in the beginning is the effect of a genuine difference between rich and poor countries, while this observed difference at the end could just as well be the result of coincidence.

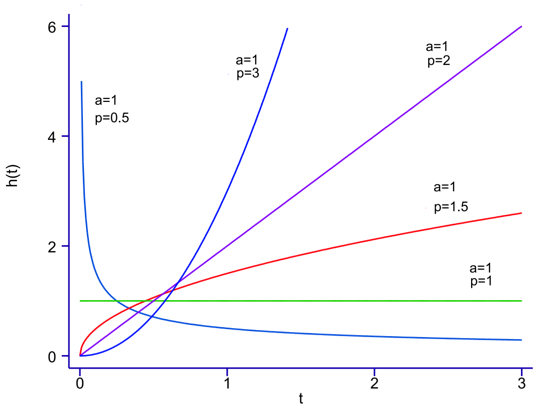
The advantage of non-parametric analysis is that the results do not depend upon any assumption (since no assumptions have been made), it just lets the data speak for itself. The disadvantage is that it can only compare a limited number of groups, so it is very difficult to see the impact of one explanatory variable while controlling for other variables. For instance if democratic countries tend to ratify faster than non-democratic countries, that might be the result of the impact of democracy on the time it takes to ratify. However it may also be the result of the fact that democracies are generally richer than non-democracies and richer countries ratify faster than poorer countries. The non-parametric techniques are not particularly good at disentangling these effects, especially when there are many of this type of effects. A second disadvantage of the non-parametric techniques is that it can only deal with qualitative explanatory variables like rich or poor countries. They cannot deal with quantitative variables like GDP per capita (because this would mean that the data has to be split in far too many groups). So, instead of looking at the impact of GDP per capita on the time it takes to ratify a treaty, the non-parametric techniques look at the difference between rich and poor countries.

D.4 Parametric analysis

We can deal with the disadvantages of non-parametric analysis mentioned at the end of the previous paragraph if we are willing to make assumptions about the functional form of the probability distribution and the way that the explanatory variables influence the risk of ratifying. Techniques that make both assumptions are called parametric techniques. This paragraph will discuss the two assumptions and the way the results of these models can be interpreted. The way in which these models are estimated will be discussed in the next paragraph.

The first assumption deals with the functional form of the probability distribution. Remember that the probability distribution summarises how the probability of ratifying changes over time. This assumption is, for this reason, also called an assumption on time dependence. One way to represent the probability distribution is the hazard function. The hazard function can be thought of as the instantaneous probability of ratifying, conditional on not having ratified so far. When we choose the functional form of the distribution we are imposing constraints on the shapes the distribution can take, but we are not fixing it completely. For instance, the simplest functional form of the probability distribution is to assume that the hazard is constant over time.

Figure D.4: Weibull



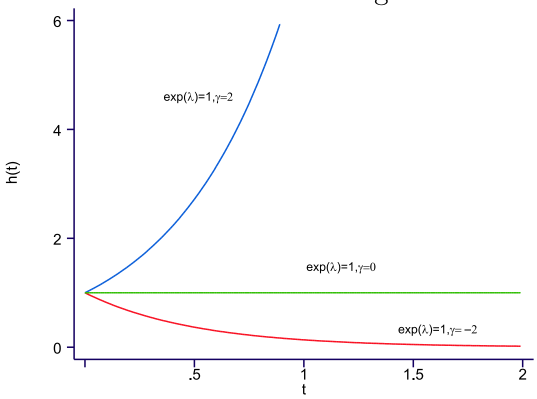
$h(t) = apt^{p-1}$

This would mean that the risk of ratifying is always the same, regardless of how long a country has been eligible to ratify. The corresponding probability distribution is the exponential model. If the risk of ratifying is constant over time, the distribution of the duration is an exponential distribution. The functional form of the exponential model is h(t) = a, whereby a is the constant level of risk. Parametric analysis chooses the level of a that best fits the data. Other distributions are characterised by more then one parameter, one that moves the hazard up or down, like the a in the exponential model, and one or more parameters that determine the shape, or the location of humps, if any. For instance the functional form of the Weibull model is h(t) = a*pt$^{(p-1)}$, whereby a is the parameter that shifts the hazard up or down, p is a parameter that determines the shape of the hazard function and t is the duration. Parametric analysis now chooses the values of a and p that best fit the data. The different shapes that are possible with a Weibull model are shown in graph D.4. Graphs D.5 through D.7 show the hazard functions of other much used models, the Gompertz, the log-logistic and the log-normal.[4] One often used model, the gamma model, is not shown, because it can have so many shapes that it would not be meaningful to show them here. These graphs show that assuming a functional form is not as restrictive as it may seem, since a wide variety of shapes are possible with only a small number of models.

These functional forms of the hazard in combination with an assumption on how explanatory variables influence the hazard can be used to estimate the impact of the explanatory variables. A simple assumption is the proportional hazard assumption, which can be used in the exponential, the Weibull and

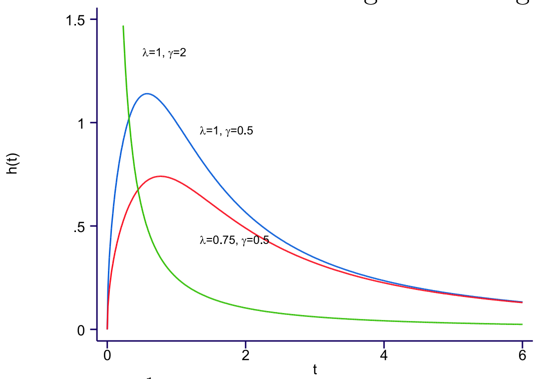
[4]Below each graph the functional form of the hazard function is shown to show where the parameters mentioned in the graphs return in the functional form.

Figure D.5: Gomperz



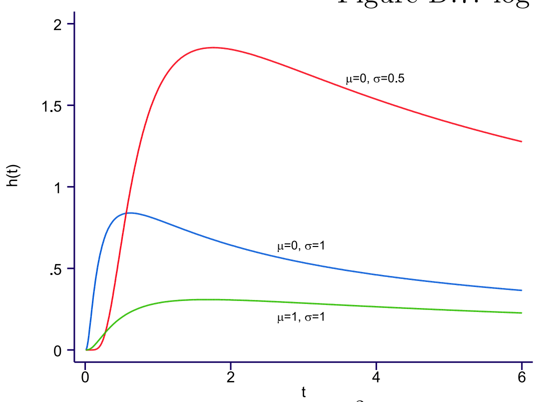
$h(t) = ae^{\gamma t}$

Figure D.6: log-logistic



$$h\left(t\right) = \frac{\lambda^{\frac{1}{\gamma}} t^{1-\gamma}}{\gamma\left(1+(\lambda t)^{\frac{1}{\gamma}}\right)}$$

Figure D.7: log-normal



$$h(t) = \frac{\frac{1}{t\sigma\sqrt{2\pi}} \exp\left(\frac{-1}{2\sigma^2}(\ln(t)-\mu)\right)^2}{1-\Phi\left(\frac{\ln(t)-\mu}{\sigma}\right)}$$

the Gompertz models. With the proportional hazard assumption we assume that all countries face a hazard function of the same shape, but that this hazard function is moved up or down with some fixed proportion for different groups of countries. An example of this type of assumption is if we assume that the risk of ratifying for G7 countries is always the same fraction higher or lower than the other countries. The model estimates that fraction. If that fraction is estimated to be 1.2, than the risk of ratifying for G7 countries is always 1.2 times the risk of ratifying for other countries, irrespective of the amount of time that has passed. The hazard function of all of these models have a part that determine its shape and a parameter a that moves the function up or down by some fixed proportion. So when we say that the hazard function for different groups is some fixed proportion higher or lower, we say that these different groups have different values for the parameter a. We can achieve this by replacing the parameter a with a function of the explanatory variables. The following example shows how this assumption is implemented. If we believe that the exponential is the right functional form of the hazard, we can estimate the effect of GDP on the risk of ratifying in the following way. The hazard function of the exponential distribution is h(t) = a, whereby a is a constant. We can replace that constant with a function of GDP, however we have to take care that the hazard can not be negative. Replacing a with $\mathrm{e}^{\beta_0+\beta_1 x_1}$ whereby x_1 is the GDP and the betas the parameters, will do the trick. Instead of finding the value of a that fits the data best, parametric analysis now finds the values of the betas that fit the data best. The betas themselves are a bit difficult to interpret, but exponentiated betas are the ratio of the hazards for a one-unit change in the corresponding covariate. For instance if we find that β_1 is 0.69 then a country will run a risk of ratifying that is $\mathrm{e}^{0.69} = 2.0$ times as large if his GDP increases with one dollar. The exponetiated parameters are called hazard ratios. Recall that we can extend the proportional hazard assumption to the Weibull and the Gompertz model. Remember that the hazard function of the Weibull is $\mathrm{h(t)} = \mathrm{a}^*\mathrm{pt}^{(p-1)}$. We can again replace the parameter a with $\mathrm{e}^{\beta_0+\beta_1 x_1}$ and the interpretation of the betas is exactly the same. The Gompertz model can also use the proportional hazard assumption. The hazard function of the Gompertz model is $\mathrm{a}^*\mathrm{e}^{\gamma t}$, and the parameter a is replaced with $\mathrm{e}^{\beta_0+\beta_1 x_1}$.

Another assumption on how explanatory variables influence the risk of ratifying is the accelerated failure time assumption. This assumption is applicable for the exponential, the Weibull, the log-normal, the log-logistic and the gamma. Basically, this assumption assumes that every country faces a hazard curve of the same shape, only time passes by slower or faster for different types of countries. A good example is the conventional wisdom that a year for a dog is equivalent to seven years for a human. So if humans have a 75% chance of surviving past the age of 70, than dogs have a 75% chance of surviving past the age of 10. This example shows that accelerated failure time models are closely related to the survivor function. Basically, the hazard functions are rewritten to a survival function, and the survival function has the following general form: S(t) = S_0(a*t), whereby a is one of the parameters and S_0 is function which depends on the model. The exponential model can be written in such a way. If the hazard function is h(t) = a, then the survival function of that distribution is S(t)=e^{-at}. We can replace the parameter a with a function of the explanatory variables, just as with the proportional hazard model. We have to take care that a*t can not be negative, and since t is always positive, a must also be always positive. To achieve this a is replaced with $e^{\beta_0+\beta_1 x_1}$. The betas now have a more or less similar interpretation as in a proportional hazard model. The exponentiated beta now is not the ratio of the hazards for a one-unit change in the corresponding covariate, but the ratio of the expected survival time for a one-unit change in the corresponding covariate. So if t is the lifespan of a number of humans and dogs, and x_1 equals 1 if the subject is human and zero if it is a dog, then we expect $e^{\beta 1}$ to be 7. The exponentiated betas are called time ratios.

A problem with parametric analysis is that we have to choose a model. Ideally, theory should lead to the choice of the model. There are however some options if the theory is silent. The estimated survivor functions can be used to evaluate whether a specific distribution is appropriate for the dataset. For instance, the exponential distribution assumes a constant hazard. If the hazard function is constant than the cumulative hazard function, H(t), is a straight upward sloping line. Since H(t) = -ln(S(t)), a graph of $-\ln\left(\hat{S}\left(t\right)\right)$ against t should yield a straight line if the distribution is indeed exponential. The conclusions that the graph of $\ln\left[-\ln\left(\widehat{S}\left(t\right)\right)\right]$ against ln(t) should be straight if the distribution is a Weibull distribution, the graph of $\ln\left[\frac{1-\widehat{S}(t)}{\widehat{S}(t)}\right]$ against ln(t) should be straight if the distribution is log-logistic, and the conclusion that the graph of $\Phi^{-1}\left[1-\widehat{S}(t)\right]$ against ln(t) should be straight if the distribution is log-normal, can be derived in similar ways. (Blossfeld and Götz 1995, 199-200)

There are other ways of choosing between models. One way uses the fact that some models are just special cases of other models. For instance, the exponential model is the Weibull model when the shape parameter p equals one. So when choosing between the Weibull and the exponential, all we have to do is estimate a Weibull model and test whether p equals one. When choosing between models that do not have such a relationship, the log likelihood can be used as a guide. Basically, this looks at the probability of observing the data we have observed if the estimated model is really true. Finally, we can look at the residuals. 'Normal' residuals can not be calculated, but pseudo-residuals can be obtained. Often used pseudo-residuals are Cox-Snell residuals. If the model fits well, than these residuals should follow a standard exponential distribution. The distribution of the actually calculated Cox-Snell residuals can be graphically evaluated. The model that produces Cox-Snell residuals that most closely resemble a standard exponential distribution is the best.

To sum up, in parametric analysis we assume that the probability distribution has a certain functional form. The functional form has one or more parameters that determine its location and/or shape. Parametric analysis finds the values of these parameters that best fit the data. Explanatory variables can be introduced by replacing one of these parameters with a function of the explanatory variables. We make an assumption on how the explanatory variables influence the risk of ratifying by doing so. If we estimate a proportional hazard model we assume that the hazard of one group is always some proportion larger or smaller then the hazard of another group. If we estimate a accelerated failure time model we assume that that every country faces a hazard curve of the same shape, only time passes by slower or faster for different groups of countries.

D.5 The likelihood function

We stated in the previous paragraph that parametric analysis finds the values of the parameters and betas that best fit the data. This paragraph will show how this is done. The method is called maximum likelihood. Maximum likelihood tries to find the values of the parameters that will maximise the probability of observing the data that were observed. An observation can be thought of as a random draw from a set of possible observations. If we know the probability distribution, we can calculate the probability of "drawing" the observation we have actually drawn. A dataset consisting of two observations can be thought of as two independent draws of the set of possible observations. The probability of observing the dataset is the product of the two probabilities of observing each individual observation. We assume that the probability distribution we have chosen is the real probability distribution. Methods to evaluate which distribution is appropriate were discussed in the previous paragraph. The probability distributions have one or more parameters, and we are interested in finding the values of these parameters that best fit the data. In other words, if we assume that the real distribution has the chosen probability distribution with a set of parameters, than we can calculate the probability of observing the data that we have observed. Maximum likelihood finds those parameters that maximise this probability, but we have to choose the probability distribution we think is applicable. In order to find the best parameters, one should first write down an expression for the probability of the data as a function of the unknown parameters.

This function is called the likelihood function. After that one should find the values of the parameters that will maximise the likelihood. The likelihood function will first be discussed for datasets without censoring and explanatory variables. After that censoring and explanatory variables will be added.

The probability of observing a dataset is the product of the probabilities of observing each individual observation, as was discussed before. Because the observation is a duration and a duration is assumed to be measured on a continuum, the probability that it will take on any specific value is 0. Instead, we represent the probability of each observation by the probability density function. This results in likelihood function D.1.

$$L(\mathbf{\Theta}) = \prod_{i=1}^{n} [f(t_i|\mathbf{\Theta})] \tag{D.1}$$

Whereby L is the likelihood, and $\mathbf{\Theta}$ a vector of parameters, like the a in the exponential or the a and the p in the Weibull. The Π means the product of all values of $f(t_i|\,\mathbf{\Theta})$. This functions has to be maximised with respect to $\mathbf{\Theta}$. This is generally done with an iterative method, which consists of trying a number of values of the parameters until they converge to a maximum.

We can use the example from paragraphs D.2 and D.3 to illustrate this. In this example we want to analyse a dataset of ten countries. We start with the dataset in which all countries ratified. This dataset is repeated in table D.9. If we assume that the exponential distribution is the best applicable distribution[5], then we are interested in finding the value of parameter a that best fit the data. The probability density function of an exponential distribution is $f(t) = e^{-at}$, so the likelihood function becomes: $L(a) = e^{-a3} * e^{-a7} * \cdots * e^{-a20}$. The value of a that maximises this function is 0.073.

The likelihood function can be changed to accommodate censored observations. If a case is censored at time t_i, all we know is that this case's duration is greater than t_i. The probability of a duration greater than t_i is given by the survivor function S(t) evaluated at time t_i. Now suppose that we have r uncensored observation and n-r censored observations. If we arrange the data so that all the uncensored cases come first, we can write the likelihood as equation D.2

$$L(\mathbf{\Theta}) = \prod_{i=1}^{r} f(t_i|\mathbf{\Theta}) \prod_{i=r+1}^{n} S(t_i|\mathbf{\Theta}) \tag{D.2}$$

Using the dummy, δ_i, which is one if the case ends in ratification or zero if the case is censored, we can write this likelihood function as functionD.3.

[5]A superficial inspection of the survival curve in figure D.1 would suggest that the risk of ratifying increases over time. That means that the exponential distribution is probably not the most appropriate, but it is very appropriate for use as an example since it has rather simple hazard, survival and probability density functions.

Table D.9: example

country	duration
West-Germany	3
Netherlands	7
Canada	12
India	13
USA	15
Thailand	15
USSR	16
Brazil	17
UK	19
Niger	20

$$L\left(\boldsymbol{\Theta}\right)=\prod_{i=1}^{n}\left[f\left(t_i|\boldsymbol{\Theta}\right)\right]^{\delta_i}\left[S\left(t_i|\boldsymbol{\Theta}\right)\right]^{1-\delta_i} \tag{D.3}$$

Here the dummy acts as a switch, turning the appropriate functions on or off, depending whether the observation is censored or not. In paragraph 5.2 we discussed that the hazard rate was the probability density function divided by the survival function. Consequently, the probability density function is the hazard function times the survival function. This means that the likelihood function can be rewritten as function D.4

$$\begin{aligned} L\left(\boldsymbol{\Theta}\right) &= \prod_{i=1}^{n}\left[h\left(t_i|\boldsymbol{\Theta}\right)\right]^{\delta_i}\left[S\left(t_i|\boldsymbol{\Theta}\right)\right]^{\delta_i}\left[S\left(t_i|\boldsymbol{\Theta}\right)\right]^{1-\delta_i} = \\ & \prod_{i=1}^{n}\left[h\left(t_i|\boldsymbol{\Theta}\right)\right]^{\delta_i} S\left(t_i|\boldsymbol{\Theta}\right) \end{aligned} \tag{D.4}$$

Again we can use the example from paragraphs D.2 and D.3 to illustrate this. Table D.10 reproduces the dataset in which a number of countries are censored. Again we assume that the exponential distribution is the best applicable distribution. The hazard function of the exponential is h(t) = a and the survival function is S(t) e^{-at}.[6] The likelihood function for this example is $L\left(a\right)=a^1e^{-a3}*a^1e^{-a7}*\cdots*a^0e^{-a20}=ae^{-a3}*ae^{-a7}*\cdots*1*e^{-a20}$. The value of a that maximises this function is 0.043.

Explanatory variables can be introduced by replacing one of the parameters with a function of the explanatory variables. This is illustrated with the help of an extension of the examples used before. Table D.11 presents the dataset used before, but now the GDP per capita in 1990 has been added as an explanatory variable.

[6]A peculiarity of the exponential distribution is that the probability density function is identical to the survival function.

Table D.10: example with censored observations

country	duration	ratified
West-Germany	3	1
Netherlands	7	1
Canada	12	1
India	13	0
USA	15	1
Thailand	16	1
USSR	16	0
Brazil	17	1
UK	19	0
Niger	20	0

Table D.11: example with GDP

country	duration	ratified	GDP
West-Germany	3	1	14341
Netherlands	7	1	13029
Canada	12	1	17173
India	13	0	1264
USA	15	1	18054
Thailand	16	1	3580
USSR	16	0	7741
Brazil	17	1	4042
UK	19	0	13217
Niger	20	0	505

Table D.12: Output parametric analysis

```
Iteration 0:   log likelihood = -10.969684
Iteration 1:   log likelihood = -10.170943
Iteration 2:   log likelihood = -10.102208
Iteration 3:   log likelihood = -10.102071
Iteration 4:   log likelihood = -10.102071
Exponential regression -- log relative-hazard form
No. of subjects =          10                    Number of obs   =        10
No. of failures =           6
Time at risk    =         138
                                                 LR chi2(1)      =      1.74
Log likelihood  =   -10.102071                   Prob > chi2     =    0.1877
------------------------------------------------------------------------------
       _t |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
      gdp |   .0000849   .0000667     1.274   0.203      -.0000457    .0002156
    _cons |  -3.984975   .8804094    -4.526   0.000      -5.710546   -2.259404

------------------------------------------------------------------------------
```

Again we assume that the exponential distribution is the best fitting distribution. This means that h(t) = a and S(t) e^{-at}, whereby a is a constant. If we think that the risk of ratifying is influenced by a number of explanatory variables than we can substitute a with a function of the explanatory variables. Since the hazard can not be negative, we must take care that the function can not be negative. This is generally achieved by substituting a with $e^{\beta_0+\beta_1 x_1}$, whereby $\beta_o$is a constant, GDP the GDP per capita and β_1 the coefficient denoting the influence of GDP. The likelihood function now becomes:

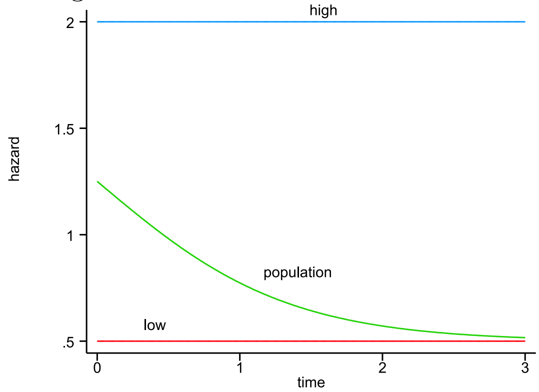
$$L(\beta_0\beta_1) = \left[e^{\beta_0+\beta_1 14341}\right]^1 e^{-\left(e^{\beta_0+\beta_1 14341}\right)} * \left[e^{\beta_0+\beta_1 13029}\right]^1 e^{-\left(e^{\beta_0+\beta_1 13029}\right)} * \cdots * \left[e^{\beta_0+\beta_1 505}\right]^0 e^{-\left(e^{\beta_0+\beta_1 505}\right)}$$

The values of β_0 and β_1 that maximise the likelihood function are -3.98 and 0.0001 respectively. These results were obtained using the statistical analysis program STATA. When estimating this model with STATA you will obtain the output presented in table D.12.

The first five lines illustrate that we are dealing with an iterative method. That is, we tried new values of the betas until the likelihood no longer improved. The first five lines give the natural logarithm of the likelihood for each attempt (iteration). The natural logarithm of the likelihood is used because STATA (and other statistical software packages) actually maximise the logarithm of the likelihood function. This function has the same maximum, but this maximum is easier to find. The sixth line tells that we are estimating an exponential model. The seventh line tells that the number of subjects (cases) is ten and that it equals the number of observations (records). If the data was split, the number of subjects would give the number of cases, and the number of observations would give us the number of records. We know that the data is not split, since the number of subjects equals the number of observations. The eighth line tells us that 6 countries ratified, which means that 4 countries are censored. The ninth line tells us that the sum of years the countries were at risk is 138 years. The left part of the eleventh line tells us that the natural logarithm of the likelihood is –10.102. The tenth and the right part of the eleventh line use this for a test (likelihood ratio test) of the hypothesis that all the betas except the constant are zero. Basically, this test compares the likelihood of a model without explanatory variables with a model with explanatory variables. The level of significance of this test is 0.19, which is above the 0.05 cut-off point, signifying that that a model with only the effect of time and without the explanatory variable GDP works just as well. The beta can be found in the column labelled "Coef." The beta of GDP, the only explanatory variable, is 0.0000849, which means that the hazard ratio is $e^{0.0000849} = 1.000085$. This can be interpreted as an increase in GDP per capita of one dollar results in a increase in the hazard of ratifying of 0.009%. The column labelled "Std. Err." gives the standard error of the estimated beta. This is used to test whether the beta is different from zero. The results of this test are presented in the columns labelled "z" and "P>|z|", whereby the last gives the level of significance. Again we find that the beta of GDP is not statistically different from zero. The last two columns give the 95% confidence interval, which can be loosely interpreted as; we are 95% sure that the real value of the beta falls within this interval.

The other models are estimated in similar ways. Only these models have multiple parameters that can be replaced by explanatory variables. For instance the Weibull has two parameters: the a and the p. If we replace a with the explanatory variables we get the parameters for the explanatory variables with the interpretation discussed in the previous paragraph. However, there is no fundamental reason why we could not estimate a model in which other parameter(s), in this case the p, are replaced by one or more of the explanatory variables. The only problem would be that the estimated betas for these explanatory variables would be much more difficult to interpret. So, this should only be done when there is strong evidence that this would seriously improve the model and when there is no other model that will produce more or less equally good results but with parameters that are more easily interpretable.

Figure D.8: effect of unobserved heterogeneity on the hazard function



D.6 Unobserved heterogeneity

An implicit assumption of the models we have considered so far is that if two individuals have identical values on the covariates, they also have identical hazard functions. Obviously, this is an unrealistic assumption. Countries differ in so many respects that no set of measured covariates can capture all the variation among them. The problem that countries differ in ways that are not fully captured by the model is called unobserved heterogeneity. One consequence of unobserved heterogeneity is that it tends to produce estimated hazard functions that decline with time, even when the true hazard is not declining for any individual country in the sample. This is most easily explained with the help of an example. Suppose we have a sample of 100 countries, all of whom have hazards that are constant over time. The sample is equally divided between two kinds of countries: those with a high hazard of ratifying (h=2.0) and those with a lower hazard of ratifying (h=0.5). Unfortunately, we do not know which countries have which hazard, so we must estimate a hazard function for the entire sample. Figure D.8 shows what happens. The hazard function for the entire population starts out, as might be expected, midway between .5 and 2. But then it steadily declines until it approaches .5 as an asymptote. What is happening is that the high hazard countries are ratifying more rapidly at all points in time. As a result, as time goes by, the remaining sample is increasingly made up of countries with low hazards. Since we can only estimate the hazard function at time t with those who are still at risk at time t, the estimated hazard will be more and more like the smaller hazard. The basic principle remains the same when the countries can be devided into more than two groups. Those with higher hazards will tend to ratify before those with lower hazards, leaving a risk set that is increasingly made up of low hazard countries. (Allison 1995, 234-35)

The betas of the explanatory variables are also influenced by unobserved heterogeneity. First of all, the coefficients may be severely biased if the unobserved components are correlated with the measured covariates, as is the case with any regression technique. For instance, suppose that democratic countries are generally rich countries and that rich countries ratify faster then poor countries and that democracy has no effect on the speed of ratification and that we do not know which countries are rich and which are poor. Democracy will in this case be positively correlated with the speed of ratification even though democracy has no effect on the speed of ratification, because democracies are generally rich and rich countries ratify faster than poor countries. So when we estimate the effect of democracy without controlling for the wealth of countries, the estimated effect of democracy will actually be a combination of the effect of democracy and some of the effect of the wealth of the countries. The estimates are however also biased when the unknown explanatory variables are not correlated with the known explanatory variables. The estimates of the coefficients will in this case be attenuated toward zero. On the other hand, the standard errors and test statistics are not biased. Therefore, a test of the hypothesis that a coefficient is 0 remains valid, even in the presence of unobserved heterogeneity.

There are ways to deal with unobserved heterogeneity. Ideally, all relevant variables are included and no unobserved heterogeneity exists, but if that is not possible a way to control for the unobserved variables is a second best option. To do that we can assume that the way countries are different can be captured by an unobserved constant specific for each individual country. This country specific constant is high when the country has a number of unknown characteristics that cause it to ratify relatively fast, and low if the unknown characteristics cause it to ratify relatively slow. This way we assume that the effects of the unobserved variables do not change over time. In our example, in which the unobserved variable splits the sample in two groups, we assume that the high hazard groups will always have a hazard that is a constant proportion larger then the hazard of the low hazard group. This is captured by the following hazard function: $\mathrm{h}(\mathrm{t}_i|\mathbf{x}_i\alpha_i) = \alpha_i\mathrm{h}(\mathrm{t}_i|\mathbf{x}_i)$, whereby α_i is the country specific constant. $\mathrm{h}(\mathrm{t}_i|\mathbf{x}_i)$ is the hazard function for an individual with an average value of the country specific constant, that is the hazard function which is not influenced by the unobserved variables. The α_i is scaled in such a way that, for example, the country specific constant will be 1.2 if the unobserved variables cause a country to ratify 20% faster then average and 0.70 if the unobserved variable cause the country to ratify 30% slower then average. The estimated parameters and betas in $\mathrm{h}(\mathrm{t}_i|\mathbf{x}_i)$ have been corrected for the unobserved heterogeneity. We do not know the values of these constants but we assume they are random draws from a probability distribution. That is, α_i is a random error term, which captures the effects of the unknown variables. We can of course estimate the correct betas and the correct shape of the hazard function if we know the correct values of the individual error terms. Problem is, we do not know these values. However we can also get the correct estimates of the betas and the shape of the hazard function if we know the probability of observing each value of the error term. The reason for this is that problem with unobserved heterogeneity is that the data consists of two or more unobserved groups and that over time the low hazard group(s) get over-represented. If we know how fast each group ratifies and what proportion of the sample belongs to each group, than we know at each point in time by how much each group is over- or under-represented. The probability distribution of the error tells exactly how fast each group ratifies and what proportion of the sample belongs to each group. Two ways are used to obtain the probability distribution of the error: a parametric and a non-parametric way.

In the parametric method we make an assumption on the functional form of the probability distribution of the error. Much used probability distributions are the gamma and the inverse Gausian. The average value of the error is in both cases assumed to be one. The shape of these distributions is then solely determined by the standard error of the error term. We can write a likelihood function, which besides the betas and the parameters also include the standard error of the error term[7]. With that likelihood function we can estimate the shape of the probability distribution of the error term together with the corrected betas and parameters. We can also test whether unobserved heterogeneity is a real problem by testing whether the standard error of the heterogeneity is zero. The intuition behind this is that all error terms will have the same value if the standard error is zero. In other words all observations belong to the same group if the standard error is zero.

In the examples used in this chapter we have always assumed that each country appears only once, however in the real dataset that is going to be analysed in this paper each country can appear multiple times. For instance, the USA is eligible to ratify 32 of the 45 treaties, so the USA appears 32 times in the dataset. We can estimate the shape of the probability distribution of the error term, the parameters and the betas while assuming that each time a country appears in the dataset it has the same error. For example with this assumption we would assure that the USA always gets the same error every time it appears in the dataset.

A major problem with the parametric way of dealing with unobserved heterogeneity is that we make an assumption about the functional form of a distribution of an unobserved variable and this assumption can sometimes have big effects on the results. The non-parametric method ensures that we do not have to make such assumptions. The non-parametric method basically assumes that the error term is not a continuous variable, but that it represents a finite number of different groups of countries. It generally starts

[7]The calculations leading to this likelihood function can get rather complex and do not add to the clarity of this paragraph, so they are not discussed here. Those who are interested in the calculations can find them in (Blossfeld and Götz 1995, 247-48) or in (Cleves et al. 2002, 261-62)

with the assumption that there are two unobserved groups of countries, the slow and the fast. That is, the error term can have only two values. This is exactly the case in the example above. The distribution of the heterogeneity is very simple: there are two groups of countries, 50% of the countries is in the fast group, which is 60% faster then average and 50% of the countries is in the slow group, which is 60% slower then average. That means that the α of members of the fast group is 1.6 and the α of members of the slow group is 0.4. Every country has a 50% chance of belonging to the slow group and a 50% chance of belonging to the fast group. If we want to make the likelihood function, we are faced by two likelihood functions: one for the countries that are members of the fast group, and one for the countries that are members of the slow group. We can not make a choice which likelihood function is applicable for which country, since we do not know to which group a country belongs. However, we do know the probability that the likelihood of the fast group is applicable and the probability that the likelihood function of the slow group is applicable: 0.5 each. That means that the likelihood of observing a duration when we do not know which likelihood function is applicable is 0.5 times the likelihood of the slow countries plus 0.5 time the likelihood of the fast countries.

This approach can be generalised and used to estimate the corrected values of the betas and the shape parameters, the proportion of countries belonging to each group and how fast or slow each group is (the alphas). In order to do so we can write the likelihood function, if we assume that the population consists of 2 unobserved groups, but we do not know the probabilities of belonging to each group as $L = pL_{slow} + (1\text{-}p)L_{fast}$, whereby p is the probability of belonging to the slow group.. This approach can easily be extended to encompass more groups. For instance, the likelihood function can be written as $L_{population} = p_1L_1 + p_2L_2 + (1\text{-}p_1\text{-}p_2)L_3$, if we assume that the population consists of three groups. Remember that the likelihood function can be written as: $L(\mathbf{\Theta}\boldsymbol{\beta}) = \prod_{i=1}^{n} [h(t_i|\mathbf{\Theta}\boldsymbol{\beta})]^{\delta_i} S(t_i|\mathbf{\Theta}\boldsymbol{\beta})$. We have already determined that the hazard function is $\alpha_i h(t_i|\mathbf{\Theta}\boldsymbol{\beta})$ in the presence of unobserved heterogeneity. The survivor function can than be written as $[S(t_i|\mathbf{\Theta}\boldsymbol{\beta}\mathbf{x}_i)]^{\alpha_i}$. The likelihood function of the slow group and the fast group can thus be written as functions D.5 and D.6.

$$L_{slow}(\mathbf{\Theta}\boldsymbol{\beta}\boldsymbol{\alpha}) = \prod_{i=1}^{n} [\alpha_{slow} h(t_i|\mathbf{\Theta}\boldsymbol{\beta})]^{\delta_i} [S(t_i|\mathbf{\Theta}\boldsymbol{\beta})]^{\alpha_{slow}} \tag{D.5}$$

$$L_{fast}(\mathbf{\Theta}\boldsymbol{\beta}\boldsymbol{\alpha}) = \prod_{i=1}^{n} [\alpha_{fast} h(t_i|\mathbf{\Theta}\boldsymbol{\beta})]^{\delta_i} [S(t_i|\mathbf{\Theta}\boldsymbol{\beta})]^{\alpha_{fast}} \tag{D.6}$$

That means that the likelihood function of the entire population can be written as likelihood function D.7.

$$L_{pop}\left(\boldsymbol{\Theta\beta\alpha}p\right) = p\prod_{i=1}^{n}\left[\alpha_{slow}h\left(t_i|\boldsymbol{\Theta\beta}\right)\right]^{\delta_i}\left[S\left(t_i|\boldsymbol{\Theta\beta}\right)\right]^{\alpha_{slow}} + (1-p)\prod_{i=1}^{n}\left[\alpha_{fast}h\left(t_i|\boldsymbol{\Theta\beta}\right)\right]^{\delta_i}\left[S\left(t_i|\boldsymbol{\Theta\beta}\right)\right]^{\alpha_{fast}} \quad \text{(D.7)}$$

The population likelihood function is a function of $\boldsymbol{\Theta}$, $\boldsymbol{\beta}$, $\boldsymbol{\alpha}$ and p. We can maximise this likelihood function with respect to $\boldsymbol{\Theta}$, $\boldsymbol{\beta}$, $\boldsymbol{\alpha}$ and p and find the corrected values of the betas and the shape parameters, the proportion of countries belonging to each group (the p) and how fast or slow each group is (the alphas). The number of groups is subsequently increased until the fit of the model no longer improves. This way any distribution can be approximated.

D.7 Semi-parametric analysis

The main disadvantage of parametric analysis, as was discussed in paragraph D.4, is that the estimates can be influenced by the two assumptions – the assumption on the way the risk of ratifying changes over time and the assumption on the way that the independent variables influence the risk of ratifying. The main disadvantage of non-parametric analysis is that it can only compare the survival functions of a limited number of groups. There is an intermediate technique whereby only an assumption is made about the way that the explanatory variables influence the risk of ratifying and it can still deal with many explanatory variables. This technique is called semi-parametric analysis, or Cox-regression. The advantage is that the results can no longer be influenced by assumptions about time-dependence, since no such assumptions are made. The disadvantages are that hypotheses about time dependence can no longer be tested and that parametric analysis yields more precise estimates than the semi-parametric analysis if the assumptions about the time dependence are correct.

Cox regression uses the proportional hazard assumption, which was discussed in paragraph D.5. Remember that it assumes that all groups of countries face a hazard function of the same shape. The only difference between groups is that the hazard functions of a group can be some constant proportion higher or lower then the hazard function of another group. For instance, if we are interested in the difference between rich and poor countries, then we assume that rich and poor countries both have a hazard function of the same shape, but that the hazard function of rich countries always lie some fixed proportion above or below the hazard function of the poor country. The strength of semi-parametric analysis is that the shape of the hazard function remains unspecified, which means that it can take any shape imaginable.

The proportional hazard assumption is captured by the hazard function of the Cox-regression, which can be written as equation D.8.

$$h_i\left(t\right) = h_0\left(t\right) e^{\beta_1 x_{i1} + \cdots + \beta_k x_{ik}} \tag{D.8}$$

Equeation D.8 says that the hazard for country i at time t is the product of two factors:

- A hazard function $h_0(t)$ that is equal for all countries and is left unspecified. This hazard function is called the baseline hazard The baseline hazard function captures the shape of the hazard function. It can be thought of as the hazard function for countries whose covariates are all zero.

- A linear function of the set of covariates, which is then exponentiated. The function of the set of covariates is exponentiated to ensure that it can not be negative. The betas have the same interpretation as the betas in the parametric proportional hazard models.

Cox-regression can estimate the values of the betas that best fit the data without having to make an assumption about the baseline hazard. It uses a method called maximum partial likelihood, which is similar to maximum likelihood. Recall that maximum likelihood tries to find the values of the parameters and the betas that will maximise the probability of observing the data that has been observed. Basically maximum likelihood looks at each country individually and calculates the probability that that country ratifies at time it did. The product of these probabilities is the probability that all the countries ratified at the time they did. This is a measure of the probability of observing the data that actually has been observed. An alternative measure is achieved when we look at each time a country ratifies and calculate the probability that at that time the country that ratified ratifies and not another country at risk of ratifying. The product of these probabilities will also be a measure of the probability of observing the data we have observed. This probability is written as a function of the unknown betas, but the baseline hazard is no longer part of this function, because being common to all countries it can not make a difference. The values of the betas that maximise this partial likelihood function, are the values of the betas that best fit the data.

The example data used in paragraph D.5 can also be used to illustrate this method. The data is repeated in table D.13. The model we are trying to estimate is $h_i\left(t\right) = h_0\left(t\right) e^{\beta_1 GDP_i}$, because GDP is the only explanatory variable. We want to find the value of beta that best fit the data without having to make an assumption about the baseline hazard. At month 3 we

Table D.13: example with GDP

country	duration	ratified	GDP
West-Germany	3	1	14341
Netherlands	7	1	13029
Canada	12	1	17173
India	13	0	1264
USA	15	1	18054
Thailand	16	1	3580
USSR	16	0	7741
Brazil	17	1	4042
UK	19	0	13217
Niger	20	0	505

ask what the probability is that West Germany ratified instead of one of the other countries. The answer is the hazard for West-Germany divided by the sum of the hazards for all the countries at risk(Cleves et al. 2002, 21-24), as is shown in equation D.9.

$$L_1 = \frac{h_{West-Germany}(3)}{h_{West-Germany}(3) + h_{Netherlands}(3) + \cdots + h_{Niger}(3)} \tag{D.9}$$

At month seven we ask what the probability is that the Netherlands ratified instead of one of the other countries. This probability is given by equation D.10. Note that Germany is no longer in the denominator since it is no longer at risk in month 7.

$$L_2 = \frac{h_{Netherlands}(7)}{h_{Netherlands}(7) + h_{Canada}(7) + \cdots + h_{Niger}(7)} \tag{D.10}$$

Note, that according to our model we can write h$_{westgermany}(3)$ as $h_0(3)$ $e^{\beta_1 GDP_{West-Germany}} = h_0(3)\, e^{\beta_1 14341}$. If we substitute the hazards with these expressions of the hazard we get equation D.11 which represents the probability that West-Germany ratified at moth 3 and not another country.

$$L_1 = \frac{h_0(3)\, e^{\beta * 14341}}{h_0(3)\, e^{\beta * 14341} + h_0(3)\, e^{\beta * 13029} + \cdots + h_0(3)\, e^{\beta * 505}} \tag{D.11}$$

We can simplify this expression by eliminating the baseline hazard. This can be done because the baseline hazard is common to every term in both the numerator and the denominator, as can be seen in equation D.12.

$$L_1 = \frac{h_0(3) * e^{\beta * 14341}}{h_0(3) * (e^{\beta * 14341} + e^{\beta * 13029} + \cdots + e^{\beta * 505})} =$$

$$\frac{e^{\beta*14341}}{e^{\beta*14341} + e^{\beta*13029} + \cdots + e^{\beta*505}} \tag{D.12}$$

We can write down the expression of these probabilities for every time a country ratified. The product of all these probabilities is the partial likelihood function, and the only unknown in this function is the beta. The value of beta that maximises the partial likelihood function (a measure of the probability of observing the data that have been observed) is the value that best fits the data, and we did not have to specify the baseline hazard.

When we estimate this model using STATA, we get the output shown in table D.14. The first five lines illustrate that we are dealing with an iterative method. That is, we tried new values of the beta until the likelihood no longer improved. The first five lines give the likelihood for each attempt (iteration). The sixth line tells that we are doing a Cox-regression and that there are no two or more countries that ratified at the same time. The seventh line tells that ten countries are observed and that the data was not split to accommodate time-varying covariates. If the data was split, the number of subjects would give the number of countries, and the number of observations would give us the number of records. The eighth line tells us that 6 countries ratified, which means that 4 countries are censured. The ninth line tells us that the sum of years the countries were at risk is 138 years. The left part of the eleventh line tells us that the natural logarithm of the likelihood is –9.6603393. The tenth and the right part of the eleventh line use this for a test (likelihood ratio test) of the hypothesis that all the betas are zero. The level of significance of this test is 0.09, which is above the 0.05 cut-off point, signifying that none of the betas is different from zero. The beta can be found in the column labelled "Coef." The beta of GDP, the only explanatory variable, is 0.00012, which means that the hazard ratio is $e^{0.00012} = 1.00012$. This can be interpreted as an increase in GDP per capita of one dollar results in a increase in the hazard of ratifying of 0.012%. The column labelled "Std. Err." gives the standard error of the estimated beta. This is used to test whether the beta is different from zero. The results of this test are presented in the columns labelled "z" and "P>|z|", whereby the last gives the level of significance. Again we find that the beta of GDP is not different from zero. The last two columns give the 95% confidence interval, which can be loosely interpreted as; we are 95% sure that the real value of the beta falls within this interval.

D.8 Conclusion

Three types of techniques where discussed in this chapter: the non-parametric, the parametric and the semi-parametric. All of them have their own ad-

Table D.14: Output semi-parametric analysis

```
Iteration 0:   log likelihood = -11.079061
Iteration 1:   log likelihood = -9.6611683
Iteration 2:   log likelihood = -9.6603393
Refining estimates:
Iteration 0:   log likelihood = -9.6603393
Cox regression -- no ties
No. of subjects =          10                     Number of obs   =        10
No. of failures =           6
Time at risk    =         138
                                                   LR chi2(1)      =      2.84
Log likelihood  =   -9.6603393                    Prob > chi2     =    0.0921
------------------------------------------------------------------------------
      _t |
      _d |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
     gdp |     .00012   .0000759      1.581   0.114      -.0000288    .0002687
------------------------------------------------------------------------------
```

vantages and disadvantages. The non-parametric allows us to gain insight with the smallest number of assumptions, but it can only compare a limited number of groups. Consequently it cannot deal with continuous variables or control for other variables. The parametric technique can deal with both discrete and continuous explanatory variables and control for a large number of other explanatory variables. However in order to estimate such a model we have to make assumptions on how the probability of ratifying changes over time (time dependence) and on how the explanatory variables influence the risk of ratifying. The semi-parametric technique requires only the last assumption. However the estimated parameters and betas will be less precise then the ones obtained from parametric analysis (provided that the assumptions made in parametric analysis are correct) and we can no longer test hypotheses about time dependence.

Appendix E

Model selection

The first task when using parametric analysis is choosing the appropriate model. This means that we have to choose a functional form along which the hazard, or the probability of ratifying, can change over time. The most important guide should be theory. No theory was put forward but some simple observations may guide the choice of the model. The risk of ratifying will be low initially and rise because the ratifying body in a country needs some time to read and discuss the treaty. This initial rise in the hazard rate as a result of the "reading time" will however be relatively short (one or two years) compared to the total time studied (42 years). After that initial rise the probability of ratifying will probably drop slowly because a treaty is likely to lose momentum or the interest of the countries after a couple of years. These observations would favour the log-normal, the log-logistic and the gamma model. In paragraph D.4 three additional methods were discussed to help making this decision. The first method consists of four manipulations of the survival function, which should yield a straight line if the corresponding model (either exponential, Weibull, log-logistic or log-normal) is appropriate. The second method consists of estimating the models and graphing a manipulation of the Cox-Snell residuals. If the model is correct the graph should be a straight line with a slope of 1. Finally, the best fitting model should be the model with the highest log likelihood. Parametric analysis finds the value of the parameters and the betas that maximise the likelihood of observing the data that have been observed if the chosen functional form is correct. The model with the highest likelihood or log-likelihood has the best fit. The manipulated Survival functions are presented in graphs E.1 through E.4, and the manipulated Cox-Snell residuals are presented in graphs E.5 through E.9. The log likelihoods and the degrees of freedom used by the model are presented in table E.1.[1]

[1]The Cox-Snell residuals and the log likelihoods of the Gamma model are not shown here since this model proved to be rather unstable. Remember that results are obtained by maximising the likelihood function using an iterative method. This iterative method can

The manipulated survival functions point to the log-normal model as the best model. The Cox-Snell residuals confirm this conclusion, although the log-logistic comes very close. The log likelihoods, on the other hand, point to the Gompertz model as the favorite, with the log-normal clearly on the second place. However, the log-normal model is chosen as the most appropriate model since the theoretical observations, the manipulated survival functions and the Cox-Snell residuals favour this model.

Table E.1 also shows a second class of models: the models that correct for unobserved heterogeneity. Here parametric frailty models will be used. These are models, which estimate one extra parameter, the standard deviation of the heterogeneity, alongside the other parameters. If the standard deviation is zero than there is no heterogeneity and unobserved heterogeneity is not a problem. Table E.1 shows that no unobserved heterogeneity was found in the log-normal, log-logistic and the Gompertz models. So these models lose one degree of freedom and gain virtually no increase in the likelihood. The likelihood ratio test is a test of whether the increase in likelihood offsets the loss of degrees of freedom, and it shows that this is clearly not the case for the log-normal, log-logistic or the Weibull model with heterogeneity.[2] As a result, the log-normal without frailty model is chosen as the best parametric model.

Finally, some concepts are measured using multiple indicators. There are three different measures of size, two for international trade and two for democracy. The measures of size and democracy will be entered separately. That means that there are six different log normal models: one with G7 and Polity IV measures for democracy, one with G7 and Vanhanen measures for democracy, one with population and Polity IV measures for democracy, and so on. The model with GDP as the measure for size and the Polity IV measure for democracy is the model with highest likelihood and thus the best fitting model. The likelihoods that are reported in table E.1 are the likelihoods of the models with these variables.

run into trouble if the likelihood function contains large sections that are approximately flat or convex. The advantage of the Gamma model is that it can take many shapes, but that also means that the likelihood function can sometimes contain large sections which are approximately flat or convex. This seems to be the case here.

[2]Unobserved heterogeneity only plays a roll when one assumes that the real hazard function has a Weibull or an exponential distribution. This is not surprising since these distributions do not fit the data very well and adding an extra parameter will enable it to approximate the observed distribution more closely. The problem is that we have to decide whether the exponential and the Weibull models without frailty did not fit the data because of unobserved heterogeneity or because they are just inappropriate models for this data. The model with unobserved heterogeneity with the best fit is the exponential with inverse gausian frailty. It is theoretically more likely that the hazard function has the shape of the preferred non-frailty model, the log-normal, than that the real hazard of ratifying remains constant over time, as is the case with the exponential model with frailty. Furthermore, the likelihood of this model is a bit worse than the likelihood of the log-normal.

Figure E.1: appropriateness of exponential model

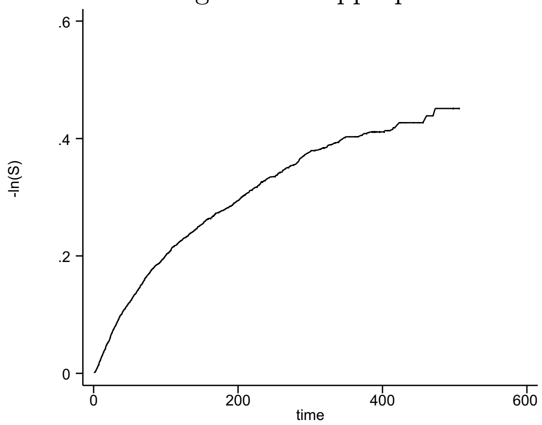


Figure E.2: appropriateness of Weibull model

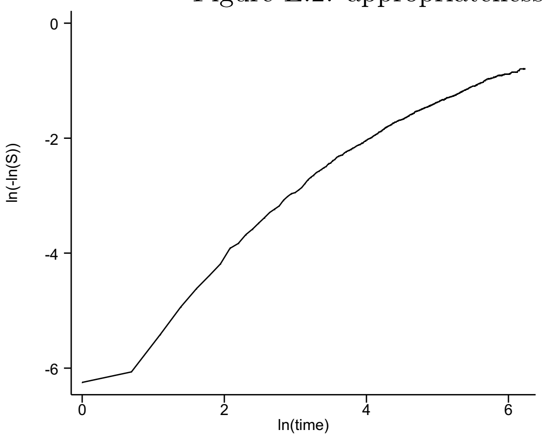


Figure E.3: appropriateness of log-logistic model

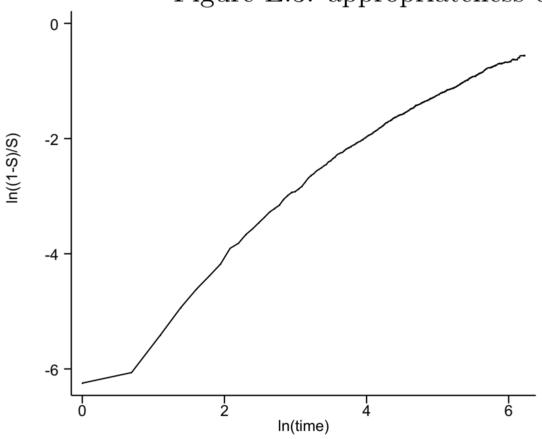


Figure E.4: appropriateness of log-normal model

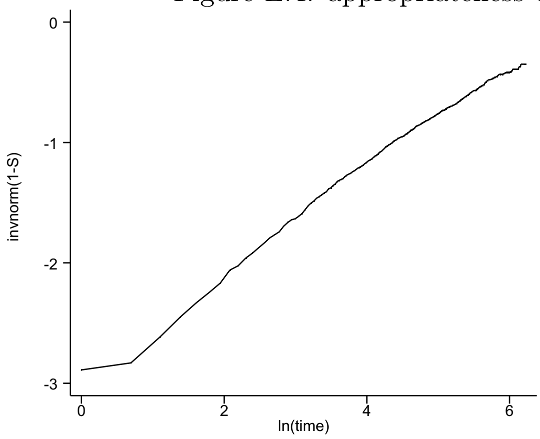


Figure E.5: residuals exponential model

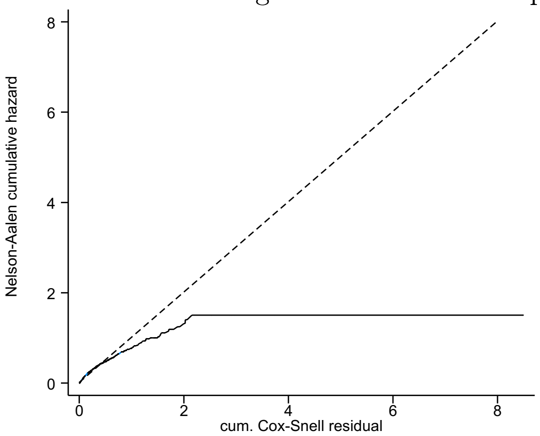


Figure E.6: residuals Weibull model

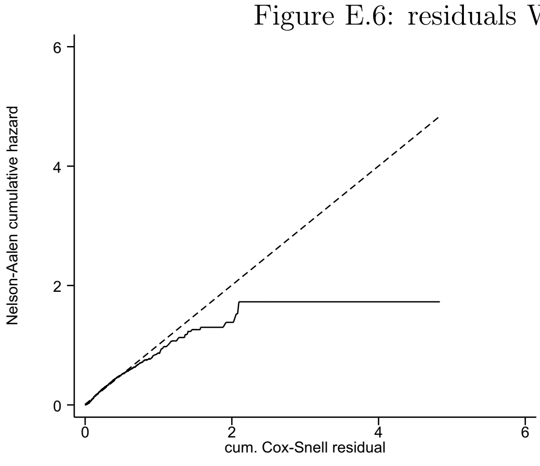


Figure E.7: residuals Gompertz model

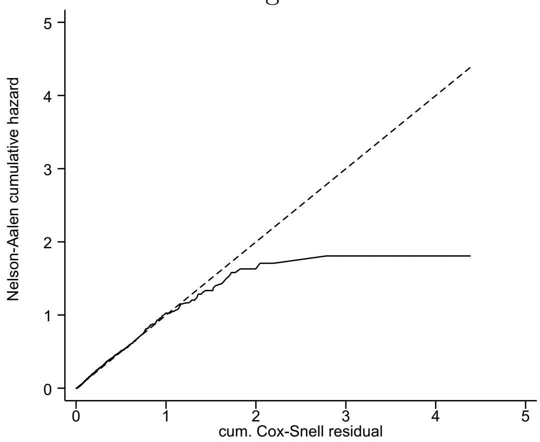


Figure E.8: residuals log-logistic model

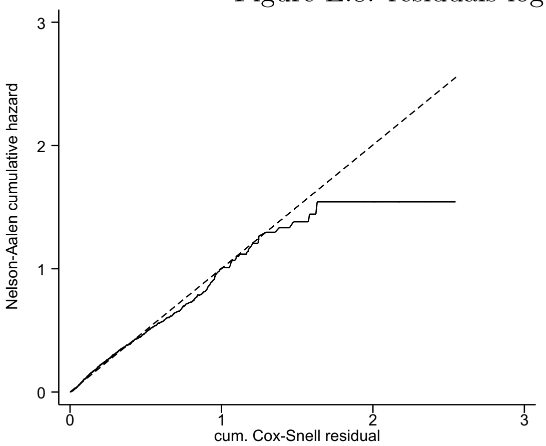


Figure E.9: residuals log-normal model

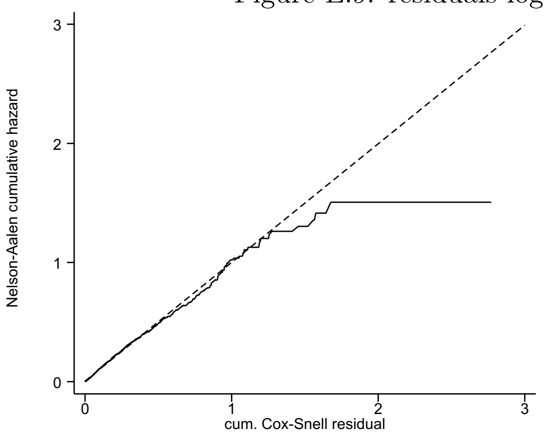


Table E.1: log likelihoods of different models

model	log likelihood	df	likelihood test standard deviation of frailty = 0 (χ^2 with 1 df)	level of significance
exponential	-2965.89	23	-	-
exponential with inverse gausian frailty	-2846.81	24	238.17	0.00
exponential with Gamma frailty	-2862.92	24	205.94	0.00
Weibull	-2887.28	24	-	-
Weibull with inverse gausian frailty	-2846.80	25	80.95	0.00
Weibull with Gamma frailty	2860.57	25	53.42	0.00
Gompertz	-2770.71	24	-	-
Gompertz with inverse gausian frailty	-2770.71	25	0.00	1.00
Gompertz with Gamma frailty	-2770.71	25	0.00	1.00
log-normal	-2835.17	24	-	-
log-normal with inverse gausian frailty	-2835.17	25	0.00	1.00
log-normal with Gamma frailty	-2835.17	25	0.00	1.00
log-logistic	-2862.06	24	-	-
log-logistic with inverse gausian frailty	-2862.06	25	0.00	1.00
log-logistic with Gamma frailty	-2862.06	25	0.00	1.00

Appendix F

Robustness of parametric model

The robustness of the results are here determined in two ways: First, by using different variables to measure the same concept and second by using different assumptions on how the risk of ratifying changes over time. Table F.1 represents the results from the first method. International trade is measured in three different ways: the volume of trade relative to the GDP in current prices, the volume of trade relative to the GDP in constant prices and a dummy denoting the absence of restrictive measures on international trade. The best model includes both the volume of international trade in current prices and the openness dummy. These two measures of international trade have different effects. This could mean that international trade is not as unidimensional as was assumed thus far. However the results do not point to a clearly interpretable subdivision. The openness dummy denoting the absence of restrictive measures could be interpreted as primarily related to imports, while the volume of international trade variable could be interpreted as being related to both imports and exports. However, in that case we would expect that the interaction term of the sum of GDP variable with the trade variable would be significant and the interaction term of the sum of GDP variable with the openness variable would be insignificant, since the strength of other countries is expected to work through the export possibilities they present. Exactly the opposite is the case. Furthermore, the interaction effects show that the sum of GDP makes international trade have a more negative effect when the volume of international trade is measured in constant prices.

Size has been measured by three different variables: GDP, population and membership of the G7. The first two measures show no effect of size or impact of international trade through size. However, the effect of G7 membership itself is large (G7 members ratify 91% faster than non-members) and international trade (measured with the openness dummy) has a negative effect through size (which is opposite to the hypothesised effect.) So the effect of size is also not robust but the conclusion that the hyptothesised effect of international trade through size did not occur is robust.

The two democracy measures have similar effects when one looks at the direction of the effects, however this is less so when one looks at the level of significance. The semi-democracy dummy from the Polity IV dataset is significant at the 5% level, while this dummy from the Vanhanen dataset is not even significant at the 10% level. The results from the democracy dummy are robust when we look at the direction of the effect and at the level of significance. The conclusion concerning the effect of democracy is thus robust. As a result, this way of assessing the robustness leads us to believe that the conclusions concerning the effects of international trade through the importance of higher standard countries is not robust and the conclusions concering the effects of the level of democracy and international trade through size are robust.

The second way of assessing the robustness of the conclusions is by comparing the results for different assumptions concerning the time dependence. We found in appendix E that two other assumptions, the log-logistic and the Gompertz, might also be applicable. These results are presented in table F.2. All trade related effects seem to be effected by this assumption. The effect of international trade through important high standard countries is not robust when comparing the results of the best fitting model with those from the log-logistic or the Gompertz models. The presence of important countries with higher standards does not make international trade have a more positive effect in the log-logistic and Gompertz models. Also, treaties dealing with non-competitive industries are found to be ratified significantly slower than treaties dealing with competitive industries in the Gompertz model. The interaction terms with international trade are however still not significant (when measured as the volume of trade) or have a perverse effect (when measured as the absence of restrictive measures). So, the conclusion still holds that the hypothesised effect of international trade through the competitiveness of the regulated industry is not supported by the data. Furthermore, size measured as the GDP has a positive effect on the speed of ratification in the Gompertz model and it makes international trade have a negative effect. The effects of the control variables are however robust. So, using this method of assessing the robustness we found that the conclusions concerning the control variables are robust. Furthermore, the conclusions concerning the hypothesised effects of international trade through the competitiveness of the regulated industry and the size of the country where robust although the effects themselves where not. The effect of international trade through the importance of high standard countries is not robust.

Table F.1: estimates of log-normal model (reported coefficients are time ratios.[a] The level of significance is shown in parentheses.)

	current trade, GDP &Polity IV	constant trade, GDP & Polity IV	current trade, Population & Polity IV	current trade, G7 &Polity IV	current trade, GDP &Vanhanen
GDP	.9992 (.258)	1.0001 (.945)			.9995 (.478)
GDP*current trade	1.0000 (.087)				1.0000 (.170)
GDP*constant trade		1.0000 (.959)			
GDP*open	1.0002 (.602)	1.0002 (.586)			1.0000 (.934)
population			.9972 (.449)		
population*trade			1.0000 (.350)		
population*open			1.0000 (.997)		
G7				.0904 (.002)	
G7*trade				.9763 (.087)	
G7*open				5.3545 (.005)	
noncompetitive	1.3709 (.098)	1.4669 (.037)	1.3777 (.093)	1.3769 (.091)	1.3883 (.086)
noncompetitive*current trade	.9974 (.497)		.9975 (.517)	.9975 (.503)	.9978 (.559)
noncompetitive*constant trade		1.0015 (.661)			
noncompetitive*open	.5689 (.029	.5602 (.025)	.5679 (.029)	.5722 (.030)	.5642 (.026)
general	.6191 (.000)	.6189 (.000)	.6206 (.000)	.6177 (.000)	.6109 (.000)
sum of GDP	.8899 (.000)	.8948 (.000)	.8902 (.000)	.8917 (.000)	.8900 (.000)
sum of GDP*current trade	1.0002 (.554)		1.0002 (.441)	1.0002 (.413)	1.0001 (.674)
sum of GDP*constant trade		1.0008 (.009)			
sum of GDP*open	.9441 (.028)	.9512 (.049)	.9438 (.027)	.9473 (.037)	.9529 (.059)
current trade	1.0065 (.026)		1.0058 (.071)	1.0072 (.004)	1.0067 (.022)
constant trade		1.0026 (.184)			
open	.7911 (.225)	.7912 (.223)	.7949 (.229)	.7512 (.136)	.7755 (.179)
mean growth	.9699 (.240)	.9644 (.147)	.9683 (.214)	.975737	.9583 (.098)
growth*current trade	1.0007 (.186)		1.0008 (.160)	1.0008 (.127)	1.0009 (.114)
growth*constant trade		1.0016 (.000)			
mean growth*open	1.0892 (.063)	1.1356 (.006)	1.0918 (.055)	1.0779 (.100)	1.0911 (.055)
democracy Polity IV	.8455 (.365)	.8513 (.384)	.8478 (378)	.9446 (.762)	
semidemocracy Polity IV	1.5967 (.016)	1.5734 (.019)	1.5454 (.026)	1.6273 (.011)	
democracy Vanhanen					.8643 (.482)
semidemocracy Vanhanen					1.2442 (.113)
ln GDP per capita[a]	-.5984 (.000)	-.5869 (.000)	-.5723 (.000)	-.5953 (.000)	-.5763 (.000)
global	26.2654 (.000)	25.9069 (.000)	25.8473 (.000)	25.9112 (.000)	25.7274 (.000)
regional	10.1642 (.000)	9.9709 (.000)	9.8396 (.000)	9.9500 (.000)	9.4765 (.000)
independence	3.7002 (.000)	3.7629 (.000)	3.8468 (.000)	3.7189 (.000)	3.6876 (.000)
labour	1.6703 (.000)	1.6653 (.000)	1.6696 (.000)	1.6542 (.000)	1.6480 (.000)
ln(sigma)	.8103 (.000)	.8142 (.000)	.8126 (.000)	.8053 (.000)	.8176 (.000)
log likelihood	-2827.232	-2829.9909	-2831.374	-2827.6265	-2904.7282

[a] For ln GDP per capita the raw coefficient is reported which can be interpreted as the percentage change in time till ratification as a result of a one-percent increase in GDP per capita

Table F.2: estimates of log-normal model (reported coefficients are time ratios for the log- normal and log-logistic models and hazard ratios for the Gompertz model.[a] The level of significance is shown in parentheses.)

	log-normal	log-logistic	Gompertz
GDP	.9992 (.258)	.9992 (.198)	1.0007 (.015)
GDP*current trade	1.0000 (.087)	1.0000 (.059)	1.0000 (.052)
GDP*open	1.0002 (.602)	1.0002 (.587)	.9996 (.037)
noncompetitive	1.3709 (.098)	1.3942 (.084)	.7821 (.043)
noncompetitive*current trade	.9974 (.497)	.9983 (.654)	1.0007 (.776)
noncompetitive*open	.5689 (.029	.5685 (.024)	1.6029 (.001)
general	.6191 (.000)	.6425 (.001)	1.2857 (.001)
sum of GDP	.8899 (.000)	.9036 (.000)	1.0982 (.000)
sum of GDP*current trade	1.0002 (.554)	1.0000 (.944)	.9999 (.508)
sum of GDP*open	.9441 (.028)	.9639 (.143)	.9986 (.893)
current trade	1.0065 (.026)	1.0058 (.040)	.9972 (.079)
open	.7911 (.225)	.8645 (.430)	1.0551 (.594)
mean growth	.9699 (.240)	.9626 (.131)	1.0198 (.212)
growth*current trade	1.0007 (.186)	1.0008 (.162)	.9993 (.050)
mean growth*open	1.0892 (.063)	1.0773 (.095)	.9537 (.055)
democracy Polity IV	.8455 (.365)	.8416 (.343)	1.0733 (.505)
semidemocracy Polity IV	1.5967 (.016)	1.5049 (.029)	.8256 (.075)
ln GDP per capita[a]	-.5984 (.000)	-.5718 (.000)	0,3591 (.000)
global	26.2654 (.000)	24.4379 (.000)	.1350 (.000)
regional	10.1642 (.000)	9.3558 (.000)	.1908 (.000)
independence	3.7002 (.000)	3.4565 (.000)	.5060 (.000)
labour	1.6703 (.000)	1.8057 (.000)	.7508 (.000)
ln(sigma)	.8103 (.000)	.2325 (.000)	-.0085 (.000)
log likelihood	-2827.232	-2853.8572	-2765.2444

[a] For ln GDP per capita the raw coefficient is reported which can be interpreted as the percentage change in the time till ratification (in the log-normal and log-logistic models) or in the hazard of ratification (in the Gompertz model) as a result of a one-percent increase in GDP per capita.

Appendix G

Proportional hazard assumption

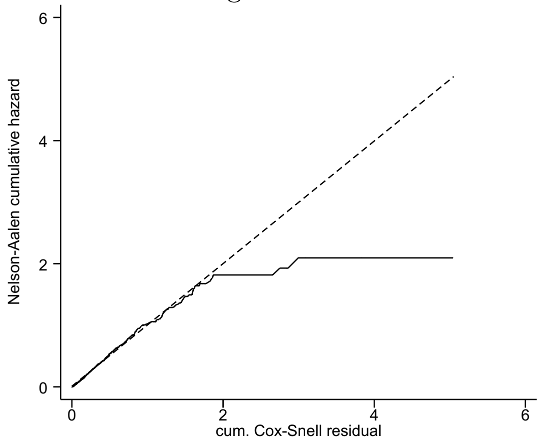
The proportional hazard assumption basically states that the effect of the explanatory variables do not change over time. A test based on Scoenfeld residuals can be used to test whether this assumption applies. This test tests whether the correlation between the residuals and time is zero. The results for a semi-parametric model whereby size is measured by GDP, international trade by the openness dummy and the volume of international trade in current prices and democracy by the Polity IV data, are displayed in table G.1 below.

Table G.1 shows that the assumption does not hold for the dummy denoting general treaties, the volume of international trade variable and the democracy and the semi-democracy dummy. A way of correcting for this problem is to stratify for these variables. Normally all groups share the same baseline hazard and they differ in the proportion they are above or below this unspecified hazard function. However, the groups for which is stratified have their own hazard function. For instance if I stratify for the democracy dummy than the democracies and the dictatorships each have their own unrelated hazard function. So when a dictatorship becomes a democracy it will move from the dictatorship hazard function to the democracy hazard function. The advantage is that the effect of democracy can change over time in any way imaginable, however the effect of democracy remains unknown, since both hazard function are unspecified. So this method is only applicable for control variables. Fortunately, all the problematic variables are control variables. However, the fit of this model remains worse than the fit of the best parametric model, even after controlling for the nonproportional hazards. This is shown in graph G.1, which represents the Cox-Snell residuals of this model. They can be used to compare the fit of this model with the fit of the parametric models. It shows that the semi-parametric model still

Table G.1: test of proportional hazard assumption based on Schoenfeld residuals

	rho	chi2	df	Prob>chi2
GDP	-0.03810	1.50	1	0.2205
GDP*trade	-0.06995	4.59	1	0.0321
GDP*open	-0.03728	1.50	1	0.2211
noncompetitive	0.04307	1.97	1	0.1604
noncompetitive*trade	0.03454	1.33	1	0.2479
noncompetitive*open	0.01259	0.17	1	0.6808
general	0.12449	16.28	1	0.0001
sum of GDP	0.03948	1.85	1	0.1736
sum of GDP*trade	0.00196	0.01	1	0.9420
sum of GDP*open	0.05257	3.18	1	0.0745
trade	-0.11224	13.35	1	0.0003
open	0.01902	0.39	1	0.5324
mean growth	0.05800	3.28	1	0.0703
mean growth*trade	0.02412	0.61	1	0.4360
mean growth*open	0.02576	0.59	1	0.4435
democracy Polity IV	0.05796	3.52	1	0.0608
semi-democracy Polity IV	0.06105	3.65	1	0.0560
ln GDP per capita[a]	-0.02135	0.42	1	0.5155
global	0.03852	1.53	1	0.2154
regional	0.02773	0.83	1	0.3631
independence	-0.04866	2.50	1	0.1139
labour	0.01431	0.18	1	0.6672
global test		69.27	22	0.0000

Figure G.1: residuals semi-parametric model



has worse Cox-Snell residuals than the log-normal parametric model. So the parametric log-normal model remains the best model.

Appendix H

Robustness of semi-parametric analysis

The robustness of the conclusions drawn from the semi-parametric analysis where tested by using different variables for the same concepts. The results are shown in table H.1. The robustness of the effects of size and international trade could be tested in this way. The effect of size is not robust. Size has itself a positive effect when it is measured as G7 membership and size makes international trade have a more negative effect when size is measured as G7 membership and international trade as the absence of restrictive measures. However, the conclusion that size does not support the hypothesis concerning the impact of international trade through the size of the country is robust. The effect of international trade is not robust but the conclusion that the effects of international trade are not supported is robust. So semi-parametric analysis provides robust support for the conclusion that none of the hypotheses concerning the impact of international trade are supported.

Table H.1: estimates of the semi-parametric model (efron method for ties, reported coefficients are hazard ratios.[a] The level of significance is shown in parentheses.)

	current trade & GDP	constant trade & GDP	current trade & Population	current trade & G7
GDP	1.000(.329)	1.001 (.000)		
GDP*current trade	1.000 (.737)			
GDP*constant trade		1.00002 (.000)		
GDP*open	.9996 (.058)	.9996 (.089)		
population			1.002 (.099)	
population*trade			1.000 (.107)	
population*open			1.000 (.971)	
G7				2.918 (.048)
G7*trade				.997 (.681)
G7*open				.298 (.002)
noncompetitive	.864 (.233)	.814 (.108)	.874 (.270)	.871 (.259)
noncompetitive*current trade	.999 (.660)		1.000 (.954)	1.000 (.843)
noncompetitive* constant trade		.999 (.634)		
noncompetitive*open	1.394 (.029)	1.448 (.020)	1.389 (.031)	1.384 (.032)
sum of GDP	1.111 (.000)	1.114 (.000)	1.111 (.000)	1.113 (.000)
sum of GDP* current trade	1.000 (.830)		1.000 (913)	1.000 (.763)
sum of GDP* constant trade		1.000 (.575)		
sum of GDP*open	1.001 (.898)	.998 (.844)	1.001 (.927)	.998 (.879)
open	1.022 (.825)	.974 (.794)	1.011 (.912)	1.053 (.611)
ln GDP per capita[a]	.357 (.000)	.357 (.000)	.342 (.000)	.344 (.000)
global	.110 (.000)	.096 (.000)	.113 (.000)	.112 (.000)
regional	.171 (.000)	.140 (.000)	.177 (.000)	.177 (.000)
independence	.519 (.000)	.505 (.000)	.515 (.000)	.504 (.000)
labour	.795 (.005)	.780 (.003)	.796 (.005)	.801 (.007)
mean growth	1.003 (.806)	1.011 (.404)	1.008 (.532)	1.005 (.661)
log partial likelihood	-4384.3926	-4123.1502	-4388.1214	-4385.0707

[a] For ln GDP per capita the raw coefficient is reported which can be interpreted as the percentage change in the hazard of ratification as a result of a one-percent increase in GDP per capita.

Appendix I

Summary

Many in the political arena perceive a trade off between success in international trade and a correct level of regulation. The fear is that the correct level of regulation is so high that companies will leave to countries with lower levels of regulation, which would lead to unemployment and poverty. International trade will thus cause politician to choose a level of regulation that is not (much) higher than the level of regulation in the most lax country. Whether there is a relationship between international trade and the level of regulation is the main question of this paper. The economic theory is a bit more complex than the fear expressed above. The standard economic theory states that differences between countries, including differences in levels of regulation, are not detrimental to international trade, the are a necessity. Not only that, it is the differences between countries that make international trade beneficial to all countries. No one complains that the Dutch orange growers face unfair competition from Spanish orange growers because of the Spanish climate. It would be a waste of resources if the Dutch try to grow oranges. The Dutch orange growing industry will of course be devastated by the competition from Spain, but the resources formerly used in this industry can now used to grow crops that better fit our climate. Note that it is not necessary for Spain to be better at growing oranges than the Netherlands. All that is necessary is that the Netherlands is better at growing some other product, say flowers, than oranges. The benefits from trade derive from specialisation and not from being better than some other country. International trade can be seen as an indirect way of producing. The Netherlands can 'produce' more oranges by growing flowers and exchanging them for oranges than by growing the oranges themselves. The same line of reasoning holds for the level of regulation. The Dutch could for instance prefer a higher level of regulation than Spanish citizens do, because they are richer or because the population density is higher in the Netherlands than in Spain. Potential reshuffles in the pattern of production are no reason to keep levels of regulation on a lower than efficient level. Some companies may move to Spain, but

the resources formerly used in these industries will now be used in industries that better fit our preferences. Supporting the effected industries by enacting less than optimal levels of regulation would be as silly and counterproductive as supporting the Dutch orange growing industry.

This means that the standard economic theory provides no reason to deviate from the optimal level of regulation. It does not mean that international trade can never influence the level of regulation. For instance, international trade can change the optimal level of regulation. Higher regulation will generally mean that fewer goods can be produced. So when looking for the right level of regulation one should balance the costs (i.e. reduced output) with the benefits of the regulation. International trade changes the price of the goods that are produced, and thus also the cost of regulation. If the world price is higher than the domestic price, than the cost of regulation will rise when international trade is allowed, since the goods that have to be sacrificed become more valuable. Similarly, if the world price is below the domestic price, than the cost of regulation will drop when international trade is allowed, since the goods that have to be sacrificed become less valuable. So international trade increases the optimal level of regulation when the country imports and decreases the level of regulation when the country exports.

Furthermore, international trade can detract from the optimal level of regulation under special but quite feasible circumstances. Four such circumstances have been discussed in this paper. The first circumstance occurs when the country is so large that it can influence world prices. In that case a country can use that fact to decrease the price of its imports by allowing a larger than efficient amount production or increase the price of its exports by allowing a less than efficient amount of production. Remember that the efficient level of regulation for exporting countries will be lower than the efficient level for importing countries. That means that size will counteract the effect of international trade on the optimal level of regulation and level of regulation will thus be more homogenous for large countries than for small countries.

The second circumstance occurs when the regulated industry is non-competitive. International trade might in that case have a negative impact on the level of regulation. It is likely that companies in a non-competitive industry receive subsidies, because this will increase the share the domestic firms can grab of the rents earned in this industry (e.g. Barret 1994) and/or because these firms have a strong bargaining position versus the government (Kobrin 1987). A low level of regulation is one way of subsidising an industry. This method has the advantage of being less obvious to the own population, foreign firms and governments and thus preventing protests. The non-competitiveness of the regulated industry causes international trade to have a more negative effect since the effect of non-competitiveness works because of international trade.

The third circumstance occurs when there are important other countries that have higher levels of regulation. International trade can in that case have a positive impact on the the level of regulation. The reason for this is that it may be difficult to export to a country if the importing country has higher levels of regulation than the exporting country, either because the people of the importing country prefer high standard goods or because the firms of the importing country resent having to compete with low standard goods and demand a 'level playing field'. Increasing the level of regulation in the exporting country might be a cheap way of signalling compliance with importing countries preferences or standards (Vogel 1995, 6). This effect is expected to increase the more important the high standard importing countries are and the more important exports are to the exporting country.

The final circumstance occurs when shifting resources between industries is costly. International trade can in this case have a negative influence on the level of regulation. Increased regulation may cause an industry to leave a country and thus necessitate a relocation of resources to another industry. The moving away of an industry is in itself not a problem, it is just a way of making the best use of the given resources and preferences for regulation. However this only works because resources can easily and cheaply be shifted between industries and this is not always the case. For instance the former workers in the industry that has moved away generally can not find new work without some form of retraining. This may cause short-term costs like unemployment. (Jaffe et al. 1995, 133)

International trade is not the only or most important cause of differences between countries in the level of regulation. It is necessary to control for other factors that might influence the level of regulation in order to effectively use some statistical techniques. Four such other causes of differences in the level of regulation will be discussed. First, differences in the influence of special interest groups may cause differences in the level of regulation. Small groups can more effectively organise a lobby than large groups since the benefits have to be shared with fewer people and the cost of organising are smaller. This means that regulations that target specific industries are subjected to a much stiffer opposition than regulations of a more general nature. (Olson 1971, 145-46) As a result we expect general regulation to be stricter than regulation dealing with specific industries. Second differences in the level of democracy may cause differences in the level of regulation. Democracies are expected to have higher levels of regulation than non-democracies. The reason for this is that the dictator is hit harder by reduced output that the people in power in a democracy and a dictator has more alternative means to reduce the negative effect of externalities on himself apart from regulation. However, the difference in effect of semi-democracies and dictatorships is less clear. Dictators have an incentive to enact regulation that increases production (so there is more for them to tax/steal). Leaders of a semi-democracy may lack the incentive the dictator has and they may lack the incentives that democratic leaders get from elections. In that case a semi-democracy will do worse that a dictatorship. However semi-democracies may also be an intermediate case, whereby a semi-democratic leader gets some but not all of the incentives a dictator has and gets some but not all the incentives a democratic leader has. A semi-democratic country will in that case hold an intermediate position between democracies and dictatorships. Third, differences in the wealth of countries may cause differences in the level of regulation. The reason for this is that richer people will demand better environmental quality or working conditions, and thus higher levels of environmental and labour regulation. Finally, differences may occur due to differences in the territorial scope of international co-operation. Countries care more about maintaining good relations with their neighbours than with the world as a whole. Efforts of international co-operation made solely with neighbours will thus be more likely to succeed than efforts made by a larger group of countries or with all the countries in the world.

These theories have been tested empirically. The analysis has two aims: first to test the hypotheses derived from the theory using the model which fits the data best and second to ascertain that the conclusions concerning the hypotheses are robust, i.e. that they do not change when slightly different assumptions are used. In order to test the theory one needs to find a way of measuring and comparing levels of regulation. The level of regulation has in this study been measured by the time it takes to ratify a treaty. This measure can be justified in two ways. First, one can assume that fast ratification of a treaty may indicate "a more intense preference for the provisions it contains" (Fredriksson and Gaston 2000: 347). Second, if we assume that there has been an exogenous upward trend in levels of regulation (due to changes in technology, knowledge or ideology), than international trade does not so much impact the level of regulation but the speed at which the level of regulation rises. Countries whose level of regulation rises fast will be fast ratifiers and countries whose regulation rises slowly will be slow ratifiers.

Dependent variables, characterised by a time until some event (in this case ratification), are best analysed using survival analysis. This type of analysis consists of three techniques: the non-parametric, the parametric and the semi-parametric technique. All techniques used the following explanatory variables. International trade will be measured in three ways: as the volume of international trade relative to the GDP in current prices, as the volume of international trade relative to the GDP in constant prices (both obtained from the Penn World tables (heston et al. 2002)) and as a dummy denoting whether or not the country has many government imposed restriction on international trade (obtained form a study by J.D. Sachs and A. Warner (1995)). The effect of these measures of international trade are allowed to differ in the parametric and semi-parametric techniques with:

- The size of the country measured by the GDP, population (both obtained from the Penn World Tables) and membership of the Group of seven major industrialised countries (G7).
- The competitiveness of the regulated industry measured by a dummy denoting whether the treaty deals with a competitive industry or not.
- The importance of high standard countries. High standard countries are those who have ratified the treaty and their importance is measured by their GDP. The importance of high standard countries is thus measured by the sum of the GDP of all countries that have ratified the treaty.

The effect of international trade through the costs of relocating resources between industries is not measured since no measure of this concept was found. Similarly, the effect of international trade through its impact on the optimal level of regulation is not measured. Testing this effect would require import and export data on the industry level and this information is not available for the time period and geographical area covered by this study (1950-1992 and almost all countries in the world).

In order to estimate the parametric and semi-parametric models one should control for other factors that could cause differences in the time till ratification. Four such factors are used in this study:

- The difference between regulation of general issues and regulation dealing with a specific industry is measured by a dummy differentiating between treaties that deal with a general issue and treaties dealing with a specific competitive industry.
- The level of democracy will be measured by two variables. Both distinguish between three categories: democracies, semi-democracies and dictatorships. The first variable is based upon the Polity IV dataset (Marshall and Jaggers 2000) which bases its classification on the institutions and rules of political decision making. The second variable is based upon a study by Tatu Vanhanen (2000) and is based upon the size of the opposition and the participation in elections.
- The wealth of a country is measured by the real GDP *per capita* in constant 1996 dollars obtained from the Penn World Tables
- The territorial scope of the treaties was measured by differentiating between global, regional and local treaties.

I hypothesised that international trade would have an impact through the size of the country, the competitiveness of the regulated industry, and the importance of high standard foreign markets. The best model supported only the last aspect, while the first two were rejected. The best-fitting model also found that rich countries ratified faster, that treaties dealing with general issues where ratified faster and that treaties with a small territorial scope where ratified faster. This model did not found evidence that democratic countries ratified faster than dictatorships. The robustness of the results was assessed in three ways. First, multiple indicators for the same concept were used where possible and the results were compared with the best fitting model. Second, the parametric model was estimated using different assumptions concerning the way the probability of ratifying changes over time and the results were compared with the best fitting model. Third, the results of the three techniques were compared with each other. The effect of international trade through the importance of higher standard countries found in the best fitting model did not prove to be robust. The effects of the strength of the business lobby, wealth, and the territorial scope of the treaty were robust. This would suggest that the level of regulation has more to do with political factors like the demands from the public, the strength of the business lobby and the pressure of neighbouring countries than with international trade.

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