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# **The determinants of bilateral World Trade Organization disputes in the agro-food sector**

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## **Abstract**

This paper analyses relevant determinants for the probability to initiate a dispute on policy measures under the World Trade Organization (WTO) dispute settlement system. The empirical analysis focuses on agro-food-related disputes to provide sector-specific information on the driving factors in dispute settlement, and complements and extends previous studies by incorporating new potential determinants. The focus is shifted to bilaterally dependent characteristics to take care of trade related and power-based relationships between Members. Contrary to recent analyses of overall trade disputes, the results show that some determinants such as export value and monetary means are not statistically significant. However, the import dependency from the defendant party could be identified as a relevant determinant in disputes.

Key words: WTO dispute, agro-food sector, binary choice model

## **Introduction**

Negotiations on improvements of the WTO dispute settlement system are going on since 1998, but seem far from completion. The major objectives are to make the system more effective and to allow equal access to developing countries. This investigation aims at identifying relevant countries' characteristics having an impact on the probability to observe a bilateral dispute between them. Information on the factors explaining Members' involvement in or absence from the system could help rationalizing the reform discussion. The empirical analysis focuses on agro-food-related disputes to provide sector-specific information on the driving factors in dispute settlement. This paper is based on a model developed by HORN, MAVROIDIS AND NORDSTRÖM (1999), but extends our previous study (GÖTZ, HECKELEI AND RUDLOFF, 2008) and the model's application

by shifting the focus to bilaterally relevant issues in disputes. Previous empirical studies are complemented by incorporating new potential trade related determinants and bilaterally dependent power-based relationships.

This paper is organized as follows: After a survey on existing empirical studies the model specification, including a discussion of considered determinants, is described. Statistical implementation and estimation results are subsequently presented before concluding.

## **Empirical analyses on general dispute initiation**

A few empirical assessments on the WTO initiation of disputes exist considering various determinants, agreements referred to, and roles in a dispute (complainant, defendant, co-complainant and interested party). Table 1 depicts their investigation period, dispute coverage, main issue of analysis and the models used. Table 2 comprises the detected influences of determinants under previous investigations.

HORN ET AL. (1999) mark the first empirical investigation by using a binomial dispute distribution model. According to their analysis the dispute initiation pattern is to a large extent reflected by the pattern of export diversity and value. GDP did not reveal a significant influence, but a country's legal capacity shows a slight positive influence on its probability to complain. BESSON AND MEHDI (2004) find empirical evidence that legal capacity matters with respect to a country's likelihood to win disputes. This supports the conclusion of BUSCH AND REINHARDT (2003) that early settlements of developing countries, i.e. in the consultation stage or in the Panel stage before a ruling, are missing due to the lack of legal capacity.

Table 1: Survey on investigation period, dispute coverage, main issue and used model of previous empirical studies

Empirical study	Investigation period and dispute coverage	Main issue of analysis	Used model
Horn et al. (1999)	WTO disputes; 1995-1998; 155 complaints; all agreements	Determinants for the initiation of complaints	Binomial dispute distribution model
Holmes et al. (2003)	WTO disputes; 1995-2002; 279 complaints; all agreements	Involvement in complaints (both sides) and success in disputes	Descriptive statistics
Bown (2004a)	GATT & WTO disputes; 1973-1998; 174 complaints; all agreements	Determinants for compliance after trade disputes	Linear regression
Bown (2004b)	GATT & WTO disputes; 1992-2003; complaints against U.S. trade remedies	Initiation of complaints against U.S. trade remedies	Probit model
Besson and Mehdi (2004)	WTO disputes; 1995-2002; 40 complaints of developing against developed countries	Success in disputes: Developing against developed countries	Probit model
Bown (2005)	WTO disputes; 1995-2000; 54 complaints; complaints against import protection on MFN-basis	Engagement as Co-Complainant or interested third party	Ordered multinomial logit model

Source: Own compilation

The self-enforcing nature of the dispute settlement system has been the starting point for BOWN (2004a, 2004b and 2005): A focus lies on costs of running a dispute and a country's retaliation power to finally enforce compliance by penalty tariffs on imports of the condemned party. BAGWELL AND STAIGER (2000) and DAM (1970) state that the retaliation threat always has been a central component of the GATT system. The success of this power is linked to the countries' relevance as trade partner and there exists also theoretical support that the retaliation threat is not uniformly distributed over Members and that imbalances relating to trade volume and market size shows influence on their force under trade disputes. BOWN (2002) demonstrates that a country's capacity to influence its terms-of-trade determines the credibility of its retaliation threat which is confirmed as well by JOHNSON (1953) and KENNAN AND RIEZMAN (1988).

BOWN (2005) concentrates on the question whether to join complaints as co-complainant or interested party and demonstrated a positive impact of the capacity to absorb legal costs on both decisions. Additionally, he identifies a positive effect of a

Member's retaliatory capacity in terms of its relevance as trading partner and a negative impact of countries' dependencies on bilateral development aid. BOWN (2004c) shows that the threat of retaliation is significant for determining whether a government chooses to abide by its international obligations. BOWN (2004b) demonstrates that the successful economic resolution to disputes is influenced by the threat of retaliation by the complainant. In respect of developing countries success in disputes BESSON AND MEHDI (2004) discover empirical support for the influence of their trade retaliation power.

Market access and exporting interests are expected to be relevant for the decision on initiation or participation and there exists empirical substantiation for this. BOWN (2005) provides support for the positive impact of a country's volume of exports at stake in its decision to attend disputes as co-complainant or interested third party and BOWN (2004d) demonstrates its positive influence on the likelihood to complain against United States (U.S.) imposed trade remedies. In the broader sense there is evidence for the relevance of trade volume or share respectively. HOLMES, ROLLO AND YOUNG (2003) reach the conclusion that a Member's trade volume determines its likelihood to file complaints on the basis of simple descriptive statistics. This supports the findings of HORN ET AL. (1999) that trade volume and export diversity are closely correlated.

BOWN (2004a) finds only limited confirmation that international obligations affect a country's decision to fulfill its commitments whereas BOWN (2005) finds empirical evidence on the positive influence of a Member's international economic relationships – measured by its engagement in preferential trade agreements – on its decision to formally engage in a dispute as co-complainant or interested third party. On the topic of success in disputes, the results of BESSON AND MEHDI (2004) suggest that international economic relationships show influence on a Member's likelihood to win and they conclude that the

reliance on bilateral assistance has a negative impact on the success. Further, they discuss the impact of military power and find confirmation for the negative influence that military powerful defendants have on the performance of developing countries in dispute.

Table 2: Survey on findings of previous empirical studies

Determinant	Empirical study	Influence on the likelihood to			
		Initiate disputes	Partake in initiated disputes	Win a dispute	Reach compliance after ruling
Export diversity	Horn et al. (1999)	+			
Exporting interest	Bown (2005)		+		
Export volume	Holmes et al. (2003)	+			
Gross Domestic Product	Bown (2005)		+		
	Horn et al. (1999)	0			
Political economy relationship with respondent	Bown (2004b)				0
	Bown (2005)		+		
	Besson & Mehdi (2004)			-	
Reliance on bilateral assistance	Besson & Mehdi (2004)			-	
	Bown (2005)		-		
Legal capacity	Horn et al. (1999)	+			
	Besson & Mehdi (2004)			+	
Military power	Bown (2004b)				+
	Besson & Mehdi (2004)			+	
Retaliatory capacity	Bown (2004d)	+			
	Bown (2005)		+		
	Besson & Mehdi (2004)			0	

+ positive influence; - negative influence; 0 no influence

Source: Own compilation

## Assessing relevance of determinants

### A binomial dispute initiation model

This analysis is based on the model first presented by HORN ET AL. (1999) but modified to capture also bilaterally dependent characteristics. Due to the limited number of disputes in bilateral relationships, efficient estimation requires that the data have to be clustered. The grouping of Members is based on the country classification by income of the WORLD

BANK (2009). Hence, Members of the same income<sup>1</sup> group constitute the complainant and the defendant clusters, resulting in 16 observations, i.e. different complainant-defendant-combinations.

The initiation decision is described through a binary choice model in which a Member group's probability to complain against another Member group is *dependent* on a set of the complainant group's traits or the characteristics of their specific environment and on trade related and power based relationships between complainant and defendant cluster. The implicated conditional probability function for this binary choice situation is the Bernoulli distribution

$$(1) \quad f(y_{ijl} | \mathbf{x}_{ijl}, \boldsymbol{\beta}) = \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})^{y_{ijl}} [1 - \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})]^{1-y_{ijl}} = \begin{cases} \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta}) & \text{for } y_{ijl} = 1, \\ 1 - \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta}) & \text{for } y_{ijl} = 0. \end{cases}$$

where  $y_{ijl}$  is the binary dependent variable which takes 1 for a complaint and 0 for no complaint,  $\boldsymbol{\beta}$  denotes the vector of K coefficients,  $i$  and  $j$  indicate the complainant and the defendant group respectively and  $l$  refers to a certain dispute initiation decision. The set of K influences is merged in vector  $\mathbf{x}_{ij}$ . Function  $\pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})$  calculates the individual probability to complain for a prospective complainant group  $i$  against a potential defendant group  $j$  which can be represented by any cumulative probability distribution function. Here, we use the widely employed conditional logistic distribution,

$$(2) \quad \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta}) = \frac{\exp(\mathbf{x}_{ij}\boldsymbol{\beta})}{1 + \exp(\mathbf{x}_{ij}\boldsymbol{\beta})},$$

which would result in the well-known Logit model when applied to single trials.

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<sup>1</sup> According to the income classification of the WORLD BANK (2009), economies are divided based on their 2007 Gross National Income per capita, calculated using the World Bank Atlas method. The groups are: low income, \$935 or less; lower middle income, \$936 - \$3,705; upper middle income, \$3,706 - \$11,455; and high income, \$11,456 or more.



The proceeding for the assessment of determinants is the reproduction of the observed sample of dispute initiation over the period from January 1, 1995 to October 31, 2007 is based on a dispute distribution function which yields probabilities for positive integers, i.e. the number of a Member cluster's initiated disputes. Assuming that the probability for a litigation decision  $\pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})$  is constant from one trial to the next and that successive trials are independent, cluster  $i$ 's probability for  $c_{ij}$  complaints in  $n_{ij}$  trials against cluster  $j$  is then specified through the Binomial distribution

$$(3) \quad f(c_{ij} | \mathbf{x}_{ij}, \boldsymbol{\beta}, n_{ij}) = \binom{n_{ij}}{c_{ij}} \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})^{c_{ij}} [1 - \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})]^{n_{ij} - c_{ij}},$$

where  $c_{ij} = \sum_l y_{ijl}$ . The expected number of group  $i$ 's complaints against group  $j$  is then

given by the expected value of the Binomial distribution,

$$(4) \quad E(c_{ij}) = n_{ij} \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta}),$$

which is strictly proportional to the number of independent Bernoulli trials  $n_{ij}$ .

The applied method is maximum likelihood estimation. Assuming that the data drawn from this Binomial distribution is independent and identically distributed with unknown parameter  $\boldsymbol{\beta}$ , the likelihood function, i.e. the joint probability density of observing the given sample of complaints  $(c_{11}, c_{12}, \dots, c_{1m}, c_{21}, \dots, c_{2m}, \dots, c_{m1}, \dots, c_{mm})$  is specified by

$$(5) \quad L(\boldsymbol{\beta} | c_{ij}, \mathbf{x}_{ij}, n_{ij}) = \prod_{i=1, j=1}^m \binom{n_{ij}}{c_{ij}} \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})^{c_{ij}} [1 - \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})]^{n_{ij} - c_{ij}}.$$

Starting from the logarithmic likelihood function

$$(6) \quad \ln L(\boldsymbol{\beta} | c_{ij}, \mathbf{x}_{ij}, n_{ij}) = \sum_{i=1, j=1}^m \left[ \ln \binom{n_{ij}}{c_{ij}} + c_{ij} \ln [\pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})] + (n_{ij} - c_{ij}) \ln [1 - \pi_{ij}(\mathbf{x}_{ij}\boldsymbol{\beta})] \right],$$

the first order conditions for a maximum are

$$(7) \quad \frac{\partial \ln L(\boldsymbol{\beta}|\cdot)}{\partial \boldsymbol{\beta}} = \sum_{i=1, j=1}^m \left[ \frac{c_{ij} - (n_{ij} - c_{ij}) \exp(\mathbf{x}_{ij} \boldsymbol{\beta})}{[1 + \exp(\mathbf{x}_{ij} \boldsymbol{\beta})]} \right] = 0 \quad .$$

Restricting the vector of determinants to a constant, the probability to complain reduces to  $\pi_{ij}(\mathbf{x}_{ij} \boldsymbol{\beta}) = \pi$  for all Member clusters  $i$  and can be determined analytically by solving

the first derivative of equation (6) with respect to  $\pi$  leading to  $\pi = \frac{\sum_{ij} c_{ij}}{\sum_{ij} n_{ij}}$ . Hence, for

the restricted model, the maximum likelihood estimator of the probability to initiate a dispute is simply the number of observed complaints over the total number of independent Bernoulli trials.

The definition of the number of independent Bernoulli trials requires information about the exact number of infringements that each Member faces, as the aforementioned binary choice model refers to the litigation decision when WTO obligations are violated. For the reason that we have no a priori information about the existence of inconsistent trade measures – their existence can merely be assured after a positive Dispute Settlement Body or Appellate Body ruling – the analysis is based on an assumption about their distribution. For HORN ET AL. (1999) the number of independent Bernoulli trials is dependent on a country's export diversification, i.e. its number of different exported goods over all products and trading partners under the regime of the WTO. Each counted bilateral export flow is considered as one trial. They worked on the assumption that “disputable trade measures” (DTM) are uniformly distributed over all bilateral export flows. The problem of this approach is that the determinants for the occurrence of disputes cannot be separately identified from the impacts on the existence of DTM, leading to an “export diversity bias”, i.e. an increase in disputes with increasing export

diversity. This problem already was a central criticism of HOLMES, ROLLO AND YOUNG (2003).

Following the approach of HORN ET AL. (1999) we try to mitigate the problem of missing information about the distribution of infringements by incorporating two new indicators: Endured Protectionism by Trade Partner and Own Imposed Protectionism. In addition to this information on the likelihood of DTM in export flows, the attempt of HORN ET AL. (1999) to select the relevant export flows is slightly modified by taking empirical instead of parameterized values for average induced litigation costs into account. The number of independent Bernoulli trials  $n_{ij}$  is then defined as the yearly average of different agro-food related export flows over the investigation period going from the complainant cluster's market to the defendant cluster's market.

### **Determinants considered**

Deviating from existing studies, this paper focuses specifically on agricultural and food-related disputes in order to develop an in-depth analysis of determinants relevant in this sector and to additionally introduce new potential determinants. The set of determinants or countries' traits already used in prior studies is reflected by agricultural trade flows characterizing the export diversity, a country's wealth and Members' trade retaliatory power. Due to limited data availability for some determinants under investigation the Members sample is limited to 53 while maintaining the distribution over income classes. Members are clustered according to the World Bank Gross National Income classification from 2007 and the data on indicators is compiled as an average of Members' data in groups. The data on disputes and on all trade related indicators (Export diversity, Average aggregate agro-food export value, Trade retaliatory power, Export dependency from defendant and Import dependency from defendant) are bilaterally

dependent, i.e. they are dependent on the relationship between the complainant and defendant Member cluster.

### Disputes data

Dispute initiations were collected that affected products of the food sector. The investigation covers the period from January 1, 1995, to October 31, 2007. Each initiation is counted once to avoid double counting, thus omitting re-uptakes of disputes that occur when the consultation period of 12 months is exceeded. For jointly filed initiations, each participant is assigned one dispute. When one Member simultaneously requests for consultations on the same subject but with different defendants each one is counted on its own. Since the European Communities (EC) is a single customs union with a harmonized trade policy and common tariffs all disputes initiated by its Members are assigned to the EC. On the other hand, when disputes are initiated against several EC Members there is only one dispute assigned, including all defendants. The data on disputes stem from WTO (2007).

### Export diversity

Here we adopt the approach first presented by HORN ET AL. (1999). The complainant groups' export diversity with the defendant clusters is calculated as the average number of their bilateral agro-food related export flows per year. The average is taken over the period 1995-2006 and different thresholds on bilateral export value apply. Strictly speaking, export diversification is not an explanatory variable, but an intrinsic component of the underlying binomial dispute distribution model as the total number of trials depends on the number of export flows. HORN ET AL. (1999) found empirical support for the dependency of a Member's activity as complainant from its export diversity, i.e. its number of different exported goods over all trading partners. The underlying principle

lies in the expectation of an increased probability to encounter infringements if a Member's export diversity increases. This is self-evident if we assume infringements to be uniformly distributed over all markets, products and trading partners. Hence, we expect the number of disputes to be positively related to clusters' amount of different bilateral export flows. The export diversification factor's explanatory contribution content is just confirmable by excluding all other variables as the expected number of complaints is proportional to the number of a cluster's export flows.

With this approach, export diversity might be underestimated for countries experiencing banned trade on SPS-grounds. This is a limitation of the analysis; however, it is mitigated to some extent by taking the average of Members' number of export flows per year. Export flows come from EURO CARE (2006) available at HS-4-level.

#### **Average aggregate agro-food export value**

To complement the information on export diversity the value of Members' aggregate agro-food related exports to the defendants' market is incorporated. The indicator provides an average over the period 1995-2006. It is assumed that the overall export value provides information on the relevance of agro-food trade of the respective trade relation between complainant and defendant cluster. Hence, the aggregate export value is supposed to show a positive impact on complainant parties' dispute initiation probability. The data on Members' trade volume comes from EURO CARE (2006).

#### **Trade retaliatory power**

Members' trade retaliatory power is seen as especially relevant for the compliance phase after a pro-complainant ruling in a dispute. The self-enforcing nature of the WTO dispute settlement system charges the complainant with the enforcement of compliance. If the defendant refuses to bring its trade regime into account with its WTO obligations the

complainant party may be entitled to impose penalty tariffs on imports from the defendant party. However, this retaliatory threat is only credible if the defendant's exports to the complainant's market accounts for a substantial amount in its total exports. The complainant cluster's Trade retaliatory power is measured as the defendant cluster's share of agro-food export value to the complainant group in the defendant group's total agro-food export value. The data on trade flows and value is from EURO CARE (2006).

#### Export dependency and Import dependency from defendant

Both indicators show the defendant cluster's relevance as trade partner. A complainant party's agro-food export sector might be more or less dependent on the defendant party's market. It is hypothesized that Members' export sector is more dependent on the defendant's market the more they export to this market in relation to their overall agro-food exports. Hence, Members' stronger Export dependency on certain trade partners is assumed to show a positive influence on their probability to complain against those partners. Members' Import dependency might show a positive or a negative influence. The more they import from certain partners relative to their overall imports the more dependent their import sector from those partners. This Import dependency might have a negative impact on their ability to impose retaliation measures against those partners for the reason that they just cannot afford to cut off the affected imports. From this follows that Import dependency might show a negative impact on their decision to initiate disputes against their respective partners because their dependency makes potential retaliation measures and thereby also the successful accomplishment of the dispute unlikely. On the other hand a high Import dependency implies a substantial amount of imports from the respective defendant, suggesting a high retaliation capacity. Hence, the indicator on Import dependency might capture the aspect of trade retaliatory power and

thereby could show a positive influence on Members' probability to complain against the respective partners. Export dependency is measured as share of the complainant cluster's agro-food export value to the defendant cluster's market in the complainant's overall agro-food export value. Members' Import dependency is measured as share of the complainant cluster's agro-food import value from the defendant cluster's market in the complainant's overall agro-food import value. The data on trade flows and values stem from EURO CARE (2006).

### Induced costs of litigation

HORN ET AL. (1999) were the first analyzing the litigation costs involved and demonstrated their relevance. Their approach is followed through the implementation of a threshold for counting a Member's bilateral export flows, thus excluding flows under a certain value not being worth to fight for: As said above, a cluster's export diversity, i.e. its number of independent Bernoulli trials  $n_{ij}$  with defendant cluster  $j$ , is obtained by averaging the number of all agro-food related bilateral export flows from Members in group  $i$  to Members in group  $j$  across years. The thresholds for the incorporation of export flows are imposed bilaterally, which means that Members' bilateral export flows are counted if its value exceeds the applied threshold. According to calculations of NORDSTRÖM (2005), average costs for dispute settlement proceedings range from \$128K to \$706K, dependent on the degree of its complexity and the per hour rate of engaged lawyers. Hence, the analysis is conducted for four different litigation cost levels, i.e. excluding all flows below the respective threshold: \$0 when no threshold is applied, \$300K for low costs, \$500K for medium costs and \$700K for high litigation costs. The impact of the adopted cost-thresholds is shown for the restricted model, i.e. to the exclusion of all explanatory variables, thus comparing different cost thresholds with

respect to the corresponding model's prediction quality.

#### **Endured protectionism by trade partner**

This is to our knowledge the first empirical effort to incorporate information about the distribution of WTO-inconsistent trade barriers to reduce the lack of information about the existence of actual infringements which is the precondition to each dispute. It is assumed that the more protective the trade policy of a country's trading partners is, the higher the probability that it faces disputable trade barriers. Hence, we expect the number of initiated disputes to be positively related to a country's faced trade restrictiveness. For this purpose the Market Access Overall Trade Restrictiveness Index (MA-OTRI) provided by KEE, NICITA AND OLARREAGA (2006) is used. It comprises a tariff equivalent of all barriers in the agro-food sector that exporters of the respective country face on average across the rest of the world. The indicator refers to data stemming from 1995-1998 concerning the non-tariff component and from 2000-2004 for the tariff component of the aggregated MA-OTRI.

#### **Own imposed protectionism**

Another hypothesis is that the number of its filed disputes is negatively related to a country's tendency towards protectionism. The rationale behind this is the assumption that a more protective Member faces also a greater likelihood to become "victim" of an accusation. We presume a more protective country to pursue a defensive and peaceful strategy to not provoke to be challenged itself. On the other hand we hypothesize that more protective countries have a lower propensity to fight for market liberalization. For this purpose the Overall Trade Restrictiveness Index (OTRI) by KEE, NICITA AND OLARREAGA (2006) is used as a measure for a country's inclination to restrictive policies. It is a tariff equivalent for all trade barriers in the agro-food sector which the



respective country imposes in average upon the rest of the world. Consequently, it provides the mirror image of the aforementioned MA-OTRI indicator, measuring the trade restrictiveness from the potential complainant cluster's perspective and refers on the same period.

#### **Capacity to absorb legal costs/wealth**

The capacity to absorb legal costs is supposed to be essential for the accomplishment of disputes as explicit compensation for litigation costs is not intended by the system. Even though the expected gains from removing the trade barrier exceed the induced litigation costs, this potential payoff lies ahead and is uncertain. For this reason each potential complainant must anticipate substantial costs that are involved by prosecution and, if applicable, also by enforcement of compliance. It is assumed that the number of complaints is positively related to a Member's capacity to absorb legal costs. As proxy for such financial means we use a country's Gross Domestic Product in US-Dollars, provided by the WORLD BANK (2007). The indicator is an average of Members' yearly reported GDP over the investigation period.

#### **Membership time**

The time of membership may be negatively related to the costs of filing a dispute as learning occurs. Hence, we suspect a Member's experience through its membership in the WTO to be positively related to its number of filed disputes. An index is created over the time since the inception of the organization until October, 2007, relating each Member's membership time to the whole observation period. The associated data is from WTO (2007c).

Table 3 provides a survey on all explanatory variables with their respective data source and expected impact on the initiation of disputes.

Table 3: Survey on explanatory variables, data and expected sign

Explanatory variables	Data	Source	Expected sign
Export diversity*	Census of different export flows on HS 4 level	EuroCARE (2006)	(+)
Average aggregate agro food export value	Overall agro-food related export value from complainant to defendant cluster	EuroCARE (2006)	+
Trade retaliatory power*	Share of defendant cluster's exports to complainant cluster's market in defendant's total exports	EuroCARE (2006)	+
Export dependency from defendant	Share of complainant cluster's exports to defendant cluster's market in complainant's total exports	EuroCARE (2006)	+
Import dependency from defendant	Share of complainant cluster's imports from defendant cluster's market in complainant's total imports	EuroCARE (2006)	+/-
Endured protectionism by trade partner	Average endured tariff equivalent	Kee, Nicita, Olarreaga (2006): Overall Trade Restrictiveness Index (OTRI)	+
Own imposed protectionism	Average imposed tariff equivalent	Kee, Nicita, Olarreaga (2006): Market Access Overall Trade Restrictiveness Index (MA-OTRI)	–
Capacity to absorb legal costs/wealth*	Gross Domestic Product	World Bank (2007)	+
WTO membership time	Index based on a member's percentage membership share over	World Trade Organization (2007c)	+

\* Influencing factors already integrated in previous empirical investigations

Source: Own compilation

## Statistical Implementation and Results

For the restricted model, the probability to complain is identical for all Members and its estimate only dependent on the number of all observed disputes and of the sum of bilateral export flows between all trading partners. Hence, improved model prediction is merely owing to changes in the distribution of export flows over Members by weighing the relevant exports flows, i.e. introducing thresholds for accounting only export flows beyond a certain value. The average number of export flows declines from 5103 in case of no threshold to 520 when the highest threshold of \$700K is used. The fit of the model is measured by two different indicators: the fraction of exact predictions and the mean of absolute deviation (MAD) between observed and predicted disputes

$$(9) \quad MAD = \frac{1}{m} \sum |c_i - \hat{c}_i|,$$

where  $c_i$  denotes the number of observed and  $\hat{c}_i$  the number of predicted disputes of Member  $i$  and  $m$  assigns the sample size of 16 observations.

The fraction of exact predictions (FEP) increases from 0.25 to 0.31 and the MAD decreases from 5.38 to 4.81 and thereby both measures show an increased fit of the model by imposing a threshold of \$300K. The model's fit is further improved by imposing the \$500K thresholds as the FEP increases to 0.38 and the MAD slightly decreases to 4.63. However, under the highest threshold of \$700K there is no further improvement of the prediction quality as the FEP remains unchanged and the MAD slightly increases to 4.69. Contrary to Horn et al. (1999) this result shows that the selection of trade flows is only relevant for the first two thresholds, but seems not to be relevant for the selection at higher values of trade in the agro-food sector. Hence, their findings that the pattern of dispute initiation is to a large extent reflected by differences in Members' diversity and value of trade is only partially supported by our result for the agro-food sector. Table 4 comprises the results for the restricted model.

Table 4: Results for the restricted model subject to different thresholds for export flows

Threshold on export flow values			Number of export flows			Mean of absolute deviations	Fraction of exact predictions
			min	max	avg		
\$0	Beta 0	-6.6938	794	13523	5103	5.38	0.25
	Prob	0.0012					
\$300K	Beta 0	-4.7910	103	2323	766	4.81	0.31
	Prob	0.0082					
\$500K	Beta 0	-4.5641	80	1975	612	4.63	0.38
	Prob	0.0103					
\$700K	Beta 0	-4.3986	71	1750	520	4.69	0.38
	Prob	0.0121					

Number of observations: 16

Source: Own compilation.

For the unrestricted model, the Akaike information criterion is utilized to select the relevant variables. Based on this, the incorporation of additional variables is traded off against the increased fit of the model. By incorporating additional explanatory variables the goodness of fit is improved regardless of the number of free parameters in the data generating process. The indicator penalizes increasing complexity thus mitigating the danger of over-fitting. It is then sought after the model specification showing the lowest information criterion value. All different model specifications are evaluated, i.e. all specifications are estimated and their corresponding information criterion value calculated. For each threshold the best specification, i.e. that one yielding the lowest information criterion value, is then selected and subject to a test on joint significant influence. For the best model under each threshold, standard errors of the coefficients are derived using bootstrap methods. The quality of the unrestricted model is further on validated by a likelihood ratio test. In this process the logarithmic likelihood function value of the unconstrained ML estimator  $\hat{\beta}$ , is compared with the likelihood function value of the constrained ML estimator  $\tilde{\beta}$ , which is obtained by maximizing the

logarithmic likelihood function subject to the linear restrictions  $\widetilde{\beta}_k = 0 \forall k \neq 0$ . The LR test statistic is computed as

$$(10) \quad LR = 2 \left[ \ln L(\hat{\beta} | c_i, \mathbf{x}_i, n_i) - \ln L(\widetilde{\beta} | c_i, n_i) \right],$$

which has a Chi-squared distribution with degrees of freedom equal to the number of imposed restrictions.<sup>2</sup>

According to this proceeding five of the considered determinants are retained in the final specifications: (1) Endured protectionism, (2) Own imposed protectionism and (3) Capacity to absorb legal costs/wealth, (4) Average aggregate agro-food export value, (5) Import dependency from defendant and the (6) WTO membership time result in a sufficient increase in the goodness of fit. However, their selection changes dependent on the imposed threshold. For the application of the \$0 threshold only Endured protectionism, Own imposed protectionism and Import dependency are selected, under the \$500K threshold WTO membership time and Average agro-food export value are additionally selected. The Capacity to absorb legal costs/wealth is only selected under the highest threshold of \$700K. Table 5 comprises the results for the selected specifications of the unrestricted model subject to different thresholds for export flows. The standard errors are given in brackets behind the respective coefficients. Except for the variable Average agro-food export value all included variables show the hypothesized sign. The variable Import dependency from defendant shows a negative influence. Only the influence of Imposed protectionism is proven to be statistically significant under all thresholds. For all other variables the hypothesis of having no significant influence could

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<sup>2</sup> Estimation, selection of variables, the likelihood ratio test and the bootstrap re-sampling and testing procedure are implemented in GAMS (General Algebraic Modeling System), see BROOKE, A., KENDRICK, D., MEERAUS, A. AND R. RAMAN (1998): GAMS – A User's Guide, GAMS Development Corporation, Washington, DC. The standard errors of the coefficients are calculated for 2000 re-sampling iterations.

not be rejected. Variables' joint significant influence is verified by an asymptotic significance test based on the bootstrapped sampling distribution of the estimator (see EFRON AND TIBSHIRANI, 1993). Compared to the restricted model, the FEP is higher and the MAD substantially lower for all thresholds indicating a better fit of the unrestricted model.

Table 5: Results for unrestricted specification selections subject to different thresholds for export flows

Explanatory Variables	Threshold on export flow values			
	\$0	\$300K	\$500K	\$700K
Beta 0	-8.92	-6.88	-7.66	-6.98
Endured protectionism by trade partner	1.77 (2.23)	1.11 (1.58)	2.43 (3.56)	0.88 (1.32)
Own imposed protectionism	-0.66 (1.55)	not included	-1.52 (3.26)	not included
Capacity to absorb legal costs	not included	not included	not included	0.98 (5.43)
Aggregate agro-food export value	not included	-0.98 (3.81)	-3.00 (8.44)	-2.89 (7.34)
Import dependency from defendant	** 2.44 (1.18)	* 2.8 (1.80)	* 4.51 (3.02)	* 4.33 (2.65)
WTO membership time	not included	not included	1.32 (3.39)	not included
Mean of absolute deviations	1.69	1.75	1.69	1.56
Fraction of exact predictions	0.63	0.63	0.69	0.69
Level of significance for likelihood ratio test on specification	1%	1%	1%	1%

Standard errors are given in parentheses.

Number of observations: 16

\* significant at the 10 % level

\*\* significant at the 5% level

Source: Own compilation.

The probability to complain per export flow covers a wide range: For the specification without threshold the highest probability is 40 times, for the highest threshold it is 19.5

times the lowest probability. However, the complainant clusters' activity in dispute initiation cannot be inferred from their probability to complain without considering the number of their export flows. For the \$500K threshold the probability of complainant cluster 4 against defendant cluster 4 is 0.02 and its number of export flows under this threshold is 1975, resulting in 43 expected disputes (but 45 actually observed). The probability for complainant cluster 4 against defendant cluster 1 is 0.006 and the number of export flows is 200, resulting in 2 expected disputes (but 1 actually observed).

The likelihood ratio test proves a significant amendment of the model based on the incorporation of the addressed determinants. For all thresholds the concerned variables' contribution could be substantiated at a 1% level.

The influence of Trade retaliatory power and Export dependency from defendant could not be substantiated.

## **Conclusions**

This paper presented an analysis of the determinants for initiating WTO disputes related to the agro-food sector. Apart from this new sectoral focus, the analysis extended the literature with a more in-depth analysis of potentially relevant determinants. The empirical model representing the number of initiated disputes by country as a sequence of Bernoulli trials – with probabilities modeled by a logistic distribution – was applied to 53 WTO Member countries. To allow for an efficient estimation those 53 Members were clustered in 4 complainant and defendant groups according to the World Bank income classification and resulting in 16 observations, i.e. different complainant-defendant combinations.

The results show that some of the determinants relevant in previous dispute studies

such as monetary means and export value could not be confirmed as statistically relevant in the context of the agro-food sector. It could be shown that the Import dependency from the defendant increases the probability to complain as the variable was proven to show a statistically significant influence in dispute initiation in the agro-food sector.

Further research should focus on the improvement of data quality to validate or disprove the findings on insignificant influences of some variables, for example the Average aggregate agro-food export value and Trade retaliatory capacity for the Members considered. A refinement of the bilateral analysis with respect to a more differentiated clustering procedure aiming at the minimization of information loss relative to the considered bilateral determinants would also be very useful.

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