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Cross-national adoption of private food quality standards

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Cross-national adoption of private food quality standards

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Cross-national adoption of private food quality standards

Abstract

Retailer initiated food quality standards are important elements to market food and agricultural products. However, farmers' certification proceeds at an unequal speed worldwide with some countries representing a large number of certified producers and others representing very few, if any. This study aims at analysing the adoption of two private food standards, BRC Food Technical Standard and GlobalGAP, at an aggregated cross-country level using data of 2007. Negative binomial models are applied to quantify the determinants of standards' spread at an aggregated level. The results of the econometric analysis reveal some (potential) barriers for farms and firms in developing countries to access this type of organisational innovation. Certificates of both standards seem to be issued more likely in countries with established trade relations with Germany, the Netherlands and the United Kingdom, home countries of the standards. Furthermore, larger countries and countries with better institutional quality host more certified firms. Finally, a country's level of economic development displays a clear non-monotonic relationship to the number of certified enterprises. Although no evidence for a general exclusion of developing countries can be found, the main implication of this paper is that third-party certification for export purposes seems to reinforce already existing trade relations, potentially hampering new entrants.

Keywords: Standards; Food quality; Adoption; BRC; GlobalGAP

Cross-national adoption of private food quality standards

Introduction

Global agricultural and food trade is governed by various standards and regulations, which can be divided into two segments. One group is formed by regulations countries may impose on imports. According to World Trade Organization (WTO) rules, these regulations are subject to the Agreements on Sanitary and Phyto-Sanitary barriers (SPS) and Technical Barriers to Trade (TBT). Another group is composed by standards which emerged from retailers' action and is required by several large retailers, some wholesalers and food service companies. By definition these standards do not fall under the SPS and TBT Agreements.

Already in 2003, Von Braun (2003) called attention to the emergence of retailer driven food quality standards. There are fears that these standards increase the inequality within countries, between farmers that are able to comply and those that are not. Additionally, standards' possible effect as new trade barrier for agricultural producers in developing and transition countries is criticised. In any case, concerns emerge that especially small farmers and/or farmers in developing countries might not be able to comply with standards and could be excluded from European and North American export markets (Reardon et al., 2001; Ponte, 2008). Campbell (2005) even raises the question whether retailer dominated standards lead to a type of re-colonisation.

However, other studies provide more positive evidence of small-holder market integration through third-party certification in African countries (e.g. Maertens and Swinnen (2009) as well as Minten et al. (2009) and the literature discussed therein).⁴

⁴ A comprehensive discussion of standard's impact on farmers in developing countries is beyond the scope of this paper. The interested reader is referred to Maertens and Swinnen (2009); Minten et al. (2009); Henson and Humphrey (2010) and Valkila and Nygren (2010).

Taking a more aggregated view and looking at the number of issued certificates, for standards such as GlobalGAP or BRC Food Technical Standard, reveals a large heterogeneity between countries. Some countries, developed as well as developing countries like Italy, Spain, Chile or Kenya, are home to hundreds of certified enterprises whereas other countries, especially countries in Eastern Europe and Central Asia, perform much poorer. Treating private standards as an organisational innovation, a rich literature aims at explaining the adoption behaviour of entrepreneurs using firm-level data. However, as pointed out by Rogers (2003), beside firm-specific characteristics, country characteristics, like technologies available, infrastructure and macroeconomic conditions as well as quality of institutions, might shape the accessibility of innovations by producers located in a respective country.

Against the described background, this paper aims at explaining the spread of food quality standards from an aggregated perspective. More specifically, we are interested in the determinants of the certification's international distribution beyond the reach of any single producer. We analyse the global spread of retailer driven business-to-business international quality standards with global relevance. As representative examples we focus on GlobalGAP and BRC Food Technical Standard.⁵ To do so, the aggregated number of issued certificates per country is explained by a set of historical, institutional and macroeconomic factors using a large cross-sectional dataset.

This paper's contribution is twofold. First, previous literature falls short in analysing the spread of private standards on a global scale quantitatively. To be able to derive conclusions if certain countries, and by this farmers and food processors in those countries, might be generally excluded from modern food chains, such a perspective seems relevant. Second, the impact of the determinants beyond the reach of individual producers, like historical,

⁵ Burrell et al. (2007) present an overview of various recently emerged food standards and Quality Assurance Systems.

institutional and macroeconomic factors, of private food quality standards' adoption across countries is unexplored so far.

The rest of this paper is organised as follows. After a short description of the two standards, the following section reviews briefly the previous literature of individual and aggregated adoption of quality standards. The section Conceptual framework and development of hypotheses prepares the analytical ground for the econometric analysis. The section Data description and methodology introduces the data and methodology applied in the econometric analysis. We use a negative binomial model to analyse the number of GlobalGAP and BRC certificates issued per country. Results of the analysis are presented and discussed subsequently in section Results and discussion. The paper ends with some concluding remarks.

Background and literature review

The nature of GlobalGAP and BRC standards

Following the terminology by Hobbs (2010) the two standards, GlobalGAP and BRC Food Technical Standard, emerged as voluntary consensus standards. They can be understood as a joint action of retailers and their interest groups.⁶ This distinguishes them from other process standards such as HACCP or ISO-based standards which have been developed by public authorities or inter-governmental organisations and aim for a consistent documentation of the production process. HACCP has been implemented as mandatory for seafood, juice and meat imports into the United States, to name one example (Anders and Caswell, 2009; Kaplinsky, 2010). Any standard mandated by governments can be brought to the dispute settlement procedure of the World Trade Organization (WTO). By definition, this mechanism does not exist for standards such as BRC and GlobalGAP which are mandated by business partners.

⁶ Other authors classify the two schemes discussed here as third-party certification, i.e. standards are not directly introduced by supplier or buyer (e.g. Hatanaka and Busch, 2008).

Furthermore, retail standards like BRC and GlobalGAP go beyond the mere documentation and require clearly defined production criteria.

GlobalGAP, previously known as EurepGAP, has been established by the European-Retail Working Group, originally an association of German, Dutch and British retailers. In the meantime, more than 40 retailers from 15, mainly Western European, countries require their suppliers to be GlobalGAP certified (GlobalGAP, 2010). The BRC standard bases on an initiative of British retailers only. Both standards started to be developed in 1997/98 and are counting today certified producers in more than 80 countries on all continents. First growers were certified some years later, e.g. in 2001 with respect to then EurepGAP. While the BRC Food Technical Standard as a post-farm gate standard is directed towards processors, GlobalGAP is targeting the process of agricultural production (pre-farm gate approach). Thus fresh agricultural products to be directly supplied to supermarkets or gastronomy can be certified by GlobalGAP. Both are in-chain standards, not to be communicated to the consumer via labels on the product.

Determinants of standards' adoption

So far, analyses of standard's adoption concentrate on determinants at the individual farm/firm-level in one country and/or certain agricultural sectors (e.g. Zaibet and Bredahl, 1997; Yiridoe et al., 2003; Henson and Holt, 2000; Turner et al., 2000). Fouayzi et al. (2006) analyse the adoption of multiple Quality Management Systems (QMS) like HACCP, organic certification, ISO 9000, and Good Agricultural Practices, among U.S. based firms in the fresh-cut produce sector, covering not only farmers but also packers, distributors, processors, retailers and importers.

The implementation of HACCP practices in UK dairy processing companies is analysed by Henson and Holt (2000). The authors derive from the results of their analysis four main

determinants of adoption: improvement of internal efficiency, pressure by customers, external legal and customary requirements and recommendation as good practice. Similarly, South African agribusiness firms named customer related factors, improvement of own products' quality and internal efficiency as well as access to foreign markets as most important factors which motivated introduction of ISO 9000 certification (Turner et al., 2000).

Studying the example of GlobalGAP, the adoption at farm level is analysed by Kleinwechter and Grethe (2006) regarding Peruvian mango producers as well as Souza Monteiro and Caswell (2009) focusing on the adoption behaviour of Portuguese pear growers. Whereas the first study relies on qualitative data analysis, the latter reveals quantitative estimates. Both studies suggest that producers' orientation towards exporting and their involvement in producer organisations increases the probability of GlobalGAP certification. Furthermore, farm size as well as vertical integration via contracts is positively correlated with certification in the case of Peruvian mango producers. Surprisingly, results by Souza Monteiro and Caswell (2009) point to no statistically significant impact of farm size on the probability of adoption.

Looking at the other side of the food supply-chain, Fulponi (2006) discusses incentives of retailers in OECD countries to set up such privately organised and to a large extent business-to-business standards. Similarly, Gereffi et al. (2005) relate the emergence of 'global commodity chains' to the activity of large retailers and brand marketers (not only on food markets) in international sourcing and increasing trade of intermediary products. Those activities can be seen as alternatives to complete vertical integration, i.e. in-house production.

There is a number of studies looking into the adoption of quality assurance systems at an aggregated level. Neumayer and Perkins (2005) as well as Guler et al. (2002) analyse determinants of aggregated ISO 9000 certification of manufacturing firms across countries. Results by Neumayer and Perkins (2005) show that countries exhibiting higher 'transnational

network ties' represent a higher number of ISO certified firms. More specifically, their terminology includes variables such as the share of exports to the EU and Japan on country's GDP, stocks of foreign direct investment (FDI), historical colonial ties to Europe and the availability of telecommunication. In the econometric analysis, all four variables are shown to significantly increase the number of ISO 9000 certificates per country normalised by population size. Guler et al. (2002) relate the diffusion of ISO 9000 to the level of inward FDI, GDP per capita and size of the labour force. An important difference between ISO 9000 and the standards discussed in this paper is the sectoral focus of retailers' standards on agriculture and food. ISO 9000 certificates are not only issued to manufacturers, but also to firms in health care, education, services and information technology (Guler et al., 2002).

Conceptual framework and development of hypotheses

In the following it is assumed that the global spread of a certain standard can be modelled theoretically as any other organisational innovation.⁷ Generally, it is assumed that the observed number of issued certificates represents the aggregated behaviour of rationally behaving producers. However, supermarkets which are expected to require certification still concentrate in Western Europe. Therefore, the following conceptual framework takes the perspective of producers supplying export markets.⁸ Theoretical approaches to explain the adoption of organisational innovations are reviewed for instance in Guler et al. (2002) and Neumayer and Perkins (2005).

Assuming a representative producer, who aims at certification if discounted benefits exceed costs of compliance. The latter are largely determined by investments the producer has to undertake, e.g. construction of grading and sanitation facilities or training of employees, as

⁷ For a literature review and comparison between determinants of adoption of technological or organisational innovations see Alänge et al. (1998).

⁸ Possible requirements of certification on domestic markets through entrance of supermarkets in developing countries are neglected here. Similarly, we neglect the possibility of substitution between long-term trade relation and request for certification (Fulponi, 2007).

well as changes in the production process, e.g. documentation and water testing. Furthermore, certification requires auditing through a third party, where, for sake of simplicity it is assumed that the producer has to bear the full cost. The benefits of certification depend on the availability of supply channels which honour certification. As mentioned above, for most countries such a marketing channel is closely linked to export destinations in high-income countries.

Aggregating over all producers in one country and comparing adoption across countries, yields between-country variation in variables beyond the reach of individual producers. Obviously, within-country heterogeneity between producers is ruled out by this approach. However, and as exemplified by the references above, case studies within one country deliver useful results of firm-level determinants of compliance. In the following, we target those determinants which frame individual behaviour. We identify four groups of potential factors influencing the number of issued certificates per country. The first group highlights the role of geographical and historical conditions. The second group concentrates on infrastructure and sectoral conditions are forming the third group. A fourth group includes measures of institutional quality and general economic development.

Geographic and historical conditions

Models of technology adoption rely heavily on formal and informal networks between inventors and potential adopters, e.g. by impacting the spread of information or knowledge transfer (Alänge et al., 1998; Geroski, 2000). It is straightforward to assume that the ease of information flows between the inventor of a standard and potential adopters matters. Eligibility for certification according to a certain standard requires the implementation of numerous tools and processes prescribed in documentations. Due to the emergence of both standards in the UK, those documentations were first written in English. Translation of the most relevant documents follows subsequently as the number of adopters in certain countries

is increasing. For instance, only selected GlobalGAP documents are currently translated into more than 20 languages. However, the English version is binding as long as translated versions are not assigned a so-called status as 'normative document'. Documentations in relation to the BRC Food Technical Standard are translated from English into slightly more than 10 languages with only Chinese and Thai as non-European languages.⁹ It is assumed here that the knowledge of English, Dutch or German is highly correlated with a country's status as a former colony.

Furthermore, because compliance is required by export destinations we expect a very close relationship between determinants of trade and determinants of aggregated compliance. In a very detailed study, Eichengreen and Irwin (1998) highlight the relevance of historical factors as colonial status and size of historical trade flows in explaining current size of trade exchanges.

Hence, former and current colonies are expected to have more certified firms.

Infrastructure conditions

Infrastructure conditions are expected to affect the probability of adoption at firm-level in various ways. Obviously, production for export purposes requires provision of transport infrastructure like roads and railways. Enterprises in countries with a poorly developed transport system face higher within-country transport costs which negatively affects the competitiveness of the respective country's products on export markets. Accordingly, producers are hypothesised to have lower incentives to adopt standards which are required on export markets. Likewise, access to information and communication increases the likelihood of getting access to information about export requirements and the likelihood of interaction between (potential) adopters. The need for documentation and plot-level traceability requires moreover the availability of advanced administrative systems for farmers. In this regard,

⁹ For more information see the standard owners' internet pages: <http://www.brc.org.uk/standards/default.asp> (BRC) and <http://www.globalgap.org> (GlobalGAP).

Neumayer and Perkins (2005) find a significant impact of a country's communication infrastructure on the aggregated number of ISO 9000 certificates per country.

Certification, and the subsequent renewals, requires an independent audit of the farm or processing firm. Generally, producers who strive for certification bear the costs of the various audits. To be qualified, the auditor has to be accredited by the owner of the standard but is requested to be independent from retailers or producers. Hatanaka et al. (2005) cite evidence that suppliers seeking certification have to rely on auditors based in Europe and have to pay their travel and living expenses. The existence of a local auditor might reduce barriers of adoption due to, for instance, lower transaction costs and better knowledge of local conditions (Barrett et al., 2002).

Sectoral characteristics

Certainly, costs of supplies still represent the most important element in traders' decision making. It is expected that firms in traditional net exporting countries exhibit implicitly comparative advantages over their competitors in other countries. Furthermore, evidence from small-holder certification shows that established exporting firms co-finance compliance costs and provide technical support to farmers (International Institute for Environment and Development and Natural Resources Institute, 2008). Thus, countries with well-established agricultural export surpluses might display a higher number of certified farms.

Additionally, intense trade relations between countries in the past might induce cohesion of organisational practices (Eichengreen and Irwin, 1998; Guler et al., 2002). Consequently, it is hypothesised that countries with a higher share of exports to Western Europe on their total agricultural and food exports are expected to have more certified firms.¹⁰

¹⁰ International competition between firms in the same supply-chain might increase diffusion of standards, or as Guler et al. (2002) term it, adoption due to 'competitive imitation pressure' to describe the increasing adoption of an innovation in one country due to the adoption rate in the destination country. However, in the case of food standards it is expected that pressure to adopt a given standard arises rather from wholesalers or processors than competitors.

Finally, EurepGAP started with modules for fresh fruits and vegetables and extended the portfolio of standards to other agricultural sectors in the following years. Due to this history it is expected to find more certified firms in countries with a higher importance of the horticultural sector in agricultural production.

Institutions and GDP

Private standards could complement already developed public regulation or act as a substitute for weak or missing public regulations. However, theory provides no clear hypothesis on this causal relationship. Empirical evidence reveals that a better institutional environment fosters adoption of quality management systems at firm-level (Correa et al., 2008) and eases international trade exchanges (de Groot et al., 2004).

Furthermore, the starting claim of a possible general exclusion of developing countries from Western European marketing channels is taken up again. Various factors might explain a potential disadvantage for firms and farmers in developing and transition countries. Producers might lack capital for necessary investments to fulfil standards' requirements. Standards developed against a European background miss a capability to be adapted to local conditions. Despite efforts to harmonise public food safety requirements internationally, it is widely recognised that developed countries display much more stringent regulations (Henson and Caswell, 1999). Therefore, farmers and firms in wealthier countries are expected to have less additional investments before being able to be certified and, hence, a higher aggregated adoption of private food standards in richer countries is expected.

Data description and methodology

Data description

For analysing the global spread of private standards, the variable of interest is the aggregated adoption behaviour across countries which we measure by using the number of firms certified

in a given country. Only independent and internationally recognised countries are included (N = 188).¹¹ That is, our unit of observation are countries and the aggregated total number of issued certificates per country presents the dependent variable in the econometric analysis. In detail and after exclusion of countries with missing explanatory variables, our sample contains 179 (GlobalGAP) and 181 (BRC) countries which enter the econometric analysis.¹² Our dependent measure is the number of certificates awarded to producers in a given country. There are 82 countries which have at least one GlobalGAP certified producer and 81 countries which have at least one BRC certified producer. This implies that out of our total sample, 97 or 100 countries have no certified producer at all. For these countries our dependent variable is equal to zero. In the case of granting joint GlobalGAP certification every farm counts as one certificate and benchmarked systems like ChileGAP or KenyaGAP are also considered. The information is sampled from online databases published by the respective provider of the two standards: BRC Food Technical Standard and GlobalGAP. All data were retrieved on November 2007.

To test for geographical and historical conditions two explanatory variables are used. Because the dependent variable is a non-normalised count variable of certifications, we control for country size using population (*POP*). Historical conditions are controlled for by a dummy variable that indicates whether a country was a former colony (*COLONY*) of one of the countries Germany, the Netherlands or United Kingdom in the case of GlobalGAP or a former UK colony in the case of BRC Food Technical Standard.

Characteristics of the infrastructure conditions are captured by a set of three variables. First, the road density per square kilometre (*ROAD*) should reflect the development of the transport infrastructure. Using a dummy variable, we control if a certified auditor has a headquarter in

¹¹ Out of the 193 internationally recognised countries, we excluded Vatican City from the analysis. GlobalGAP reports to have certified firms in Taiwan (total of 20 firms), West Bank (1 firm), Martinique (44 firms) and Puerto Rico (2 firms). Due to limited data availability, these four regions are excluded from the analysis.

¹² Because no country is exporting to itself, Germany, the Netherlands and UK have been excluded in explaining GlobalGAP certification and UK has been excluded explaining BRC certification.

the respective country (*AUDIT*). Finally, access to transnational information networks is captured by using the number of internet subscribers per 100 inhabitants (*WWW*). A better approximation would be to control for internet access in rural areas only. Unfortunately, data at such a level of detail are not consistently available.

Trade intensity and customer requirements related variables (sectoral conditions) include a country's openness (*OPEN*), measured by the share of exports and imports on GDP, and three indicators of agricultural trade. The variable *AXSHARE* measures the importance of agricultural exports relative to each country's total exports. The variable *NETXPAG* gives an indication of a country's position in world trade of agricultural products by quantifying the value of net agricultural exports. The relative importance of trade relations with Germany, The Netherlands and UK is approximated in terms of the share of a country's total agricultural and food exports (from the nation under consideration) to all three countries on its total exports (*TRADESHARE*). This measure is calculated as the sum of a country's exports to the three countries Germany, The Netherlands and United Kingdom over the total agricultural and food exports of the country under consideration. The relative importance of trade relations with Western European countries comprises two drivers: First, compliance with standards is essential to retain the position on these markets and, second, already existing export flows indicate a compliance with publicly mandated food quality standards. The production of fruit and vegetables normalised by the size of the agricultural population (*FVPROD_{pac}*) reflects the importance of the horticultural sector in a country and should indicate a relative specialisation in high-value agricultural sectors. All trade and production related variables are averages of the years 1995 to 2000 to reduce the influence of short-term variations induced by business cycles, exchange rate variability or weather.

There could be concern about a possible endogeneity of the trade related measures as certification can lead to more trade. However, all standards have been developed after 1998

and first certificates issued in 2001. Thus it is argued that possible trade intensification, if any significant increase will take place, will show up with some time lag, i.e. well after the year 2000.

Finally, we test for the impact of the institutional quality and GDP per capita. The variable rule of law (*LAW*) serves as a proxy of the quality of institutions. It gives an indication of perceptions of the effectiveness and predictability of the judiciary and the enforceability of contracts. GDP per capita in its logarithmic form (*LGDPpc*) is included to capture a possible exclusion of developing countries from Western European food chains as well as endowment differences across countries that are omitted in the other variables. Additionally, a possible non-monotonic relationship is tested using the squared GDP per capita (*LGDPpc2*).

We follow the argumentation of Comin and Hobijn (2004) that the explanation of the adoption of (micro-)technologies by considering overall macroeconomic factors reduces possible simultaneous bias. Obviously, it seems to be unrealistic to expect an effect of food standard adoption at farm level on total agricultural trade, infrastructure or even GDP. Descriptive statistics of all variables used in the following empirical analysis and sources of the data are listed in Table 1.

Table 1 around here

Methodology

Obviously, the number of certificates per country represents a strictly non-negative count variable. Additionally, the total number of certificates per country is highly skewed and far from being continuously distributed beyond the point of truncation.¹³ Under the assumption

¹³ Data could be transformed using natural logarithm or Box-Cox transformation. However, any of these transformations require strictly positive values, thus will lead to missing values for countries without any certified firm. Alternatively, the number of certificates could be normalised relative to the number of inhabitants. Figure A1 in the Appendix shows the distributions of the number of certificates per country and their

that certification owners have no interest to over- or underreport the variable of interest, there is no latent variable. However, many countries have no certified firm at all, leading to the presence of a high number of zeros. These countries form a heterogeneous group which encompasses small nations with low or even no agricultural exports to Western Europe as well as countries which do supply agricultural products to markets within the EU which do require certifications. Expressed differently, the currently observed values of zero represent a great variation of countries and this group shows a short-run picture only. Out of this group producers in some countries might gain certificates at a later point in time. However, in other countries compliance costs will always outweigh potential benefits and no producer will strive for certification. Finally, producers in countries without any certified enterprise might have no interest in certification due to missing links to export markets in Western Europe. Such a data generating process leads to a class of count data models (Winkelmann, 2008). Within this class of models it is possible to test for the nature of the data generating process. Thus, we can test whether countries without any certificate belong to different groups. In other words, controlling for zero-inflation allows for the presence of separate processes for the count outcome equation, the number of issued certificates, and for the selection mechanism, the existence of any certificate at all.

A standard count data model to explain the number of issued certificates can be represented in a general form of a conditional probability function:

$$\Pr(Y_i = y_i | x) = \frac{\exp(-\exp(x_i' S)) \exp(y_i x_i' S)}{y_i!}, y_i = 0, 1, 2, \dots \quad (1)$$

where x is a vector of explanatory variables including a constant and S is a vector of parameters to be estimated. It is assumed that the observations are independently distributed across countries. Depending on the characteristics of the dependent variable's variance, a

transformations using Kernel Density Estimation. However, for every standard the distribution of certified firms is highly positively skewed and many countries have no certified firm at all.

Poisson specification or a negative binomial specification is the preferred estimation strategy. In the case of overdispersion, as the variance exceeds the mean, a negative binomial model (NB) is more appropriate compared to a Poisson model.¹⁴ From a theoretical perspective it is noteworthy that the NB model, as a more general count data model, does not rely on the assumption of an underlying Poisson process. Furthermore, the NB model opposed to the Poisson model is capable to deal with the impact of unobserved heterogeneity on the variation of the dependent variable.

More specifically, the NB model takes the form:

$$\Pr(Y_i = y_i | x_i, r) = \frac{\Gamma(y_i + r)}{\Gamma(r) y_i!} \frac{\exp(y_i x_i' S) r^r}{(\exp(x_i' S) + r)^{y_i + r}}, y_i = 0, 1, 2, \dots \quad (2)$$

The overdispersion parameter r will be estimated and serves as a more formal test of overdispersion in the data. In a standard parameterisation the NB model has the following variance function:

$$\text{Var}(y_i | x_i) = \exp(x_i' S) \left(1 + \frac{1}{r} \exp(x_i' S) \right). \quad (3)$$

A generalisation of the model by estimating the shape parameter allows for a more flexible form of the variance function. More specifically, the exponent P in the Eq. 4 can be estimated using covariates, resulting in a generalised negative binomial model (GNB):

$$\text{Var}(y_i | x_i) = \exp(x_i' S) \left(1 + \frac{1}{r} \exp(x_i' S)^{P-1} \right). \quad (4)$$

Taking up the above mentioned observation of a large share of countries with no certified enterprise at all, the standard NB model can be extended as mixture model. Whereas the so-called hurdle model departs from two distributions, one over zero and the other over the non-zero counts, the zero-inflated model adds more weight at zero but still relies on the same data generating process. More specifically, the analysis of data in the hurdle model is separated

¹⁴ Comparing mean and variance of the dependent variable indicates the presence of overdispersion. Over the total sample the ratio of variance to mean is 6,753 for GlobalGAP and 973 for BRC Food Technical Standard.

into two steps. First, the probability of an observation of zero is estimated using a logit model and followed by the estimation of the conditional probability of the positive non-zero observations using a truncated-at-zero NB or Poisson model. On the contrary, the zero-inflated count data model still relies on the whole sample by being based on a regular count data probability function for the non-zero observations. For a more detailed description of the various models the reader is referred to Winkelmann (2008).

In the following we will start testing the Poisson assumption of equidispersion of the dependent variable. Given a rejection of this assumption, we will proceed with the family of NB models. Furthermore, the above mentioned heterogeneity of countries with no certified enterprises at all will be tested explicitly by specifying a hurdle and a zero-inflated NB model. The absence of zero-inflation would point to a theoretically equal access to certification for producers in all countries. Finally, the specification of the variance function will receive attention by estimating a generalised NB model. Model selection will base on Akaike Information Criterion and specification tests. However, a comparison of the zero-inflated and generalised NB model by means of a statistical test is unexplored so far.

Results and discussion

Descriptive analysis

To give more insight into the dependent variables used in this study, Table 2 shows the distribution of certified producers, as of autumn 2007, according to their continent. With respect to the distributed certificates, the two European standards show a dominating concentration on European countries. GlobalGAP reaches a higher number of producers worldwide. The countries with the highest number of GlobalGAP certificates are Spain and Italy, both with more than 12,000, and Greece with more than 8,000 certified farms. As expected the United Kingdom leads the list of BRC certificates with more than 2,000

followed by Italy with nearly 800 certified food processors. North and Latin America follow on the second place in the case of GlobalGAP and Asia in the case of BRC. The first standard has more than 1,000 certified farmers in Chile and Argentina and close to 1,000 in Peru. Thus these three countries account for more than half of the issued certificates in North and Latin America (exactly 56%). The BRC standard is especially widespread in the Asian countries China and Thailand, again accounting for nearly two-third of all certificates issued in Asia (exactly 65%). In terms of per capita counts, issued certificates per 1,000 inhabitants, mainly smaller European countries and New Zealand lead the list for both standards. The ranking of countries according to the number of issued certificates of both standards is highly correlated.¹⁵

Table 2 around here

A similar picture as indicated above emerges from looking at the distribution of certified producers over all countries. Although many countries have at least one certified firm, only a handful of countries have more than 100 certified firms. The box plots in Figure 1 illustrate this observation. The median is eight certified firms regarding BRC and 51 in the case of GlobalGAP. Seventy five per cent of the countries with any certified firm (upper border of the boxes) have less than 48 (BRC) and 392 (GlobalGAP) certified firms, respectively.

Figure 1 around here

¹⁵ The Spearman rank correlation coefficient is 0.68 ($p < 0.001$) over the whole sample and 0.58 ($p < 0.001$) regarding countries with a joint existence of both standards.

Econometric analysis

The results of the econometric analysis are presented in the following. To start with, Table 3 displays the results of various specification tests.

Table 3 around here

Obviously, overdispersion of the dependent variables is reduced after controlling for explanatory variables but is still statistically significant. Therefore, the NB model is preferred over the Poisson model. Again, a similar result is obtained for comparing zero-inflated Poisson models versus zero-inflated NB models. For both retailers' standards, the Vuong test indicates the statistically significant presence of excess zeros which are not sufficiently explained by the explanatory variables. Put differently, the significance of zero-inflation suggests a heterogeneous group of countries with no certificates at all. Thus firms in some countries out of this group might be eligible for certification in the future but, incidentally, did not apply for it yet and firms in other countries might generally not be interested or eligible.

Based on this result four different models of the negative binomial family have been estimated: a NB, a hurdle NB, a zero-inflated NB and a generalised NB. The obtained log-likelihood values, overdispersion parameters and the Akaike Information Criteria (AIC) are displayed in the Appendix A (Table A1). The zero-inflated NB and the generalised NB are clearly preferred against the standard and the hurdle NB models.¹⁶ Additionally, the hurdle NB has been given lower attention due to its rather strict assumption of only one type of countries with any certified firm.

Tables 4a and 4b show the results of the zero-inflated and the generalised NB model as both models reveal different aspects of the adoption process. On the one hand, the zero-inflated

¹⁶ Estimation results of all four models are available from the authors upon request.

model helps to identify determinants which explain the non-existence of certificates explicitly. On the other hand, the parameterisation of the variance function reveals information which determinants affect the variance of the dependent variable.

Tables 4a and 4b around here

As indicated by the Wald-test statistic the explanatory variables are jointly significant in explaining the number of certified enterprises. The estimated parameter τ of the zero-inflated NB points still to overdispersion of the dependent variable.

Regarding historical and geographical conditions it is shown, that status as a former colony (*COLONY*) has either no impact or even significantly lowers the number of certificates. Neither former British colonies show any significant difference in the number of BRC certificates per country nor does the country's status as a former colony has any impact on the probability to have at least one certified firm. Surprisingly, former colonies of the EUREG countries, Germany, the Netherlands or UK, are predicted to have between 35 and 54 GlobalGAP certificates less than non-colonies. Our result, is in contrast to findings by Neumayer and Perkins (2005), where the time length of colonial status increases the number of ISO 9000 certificates. This finding might lead to the conclusion that former colonial status influences compliance with standards in manufacturing differently from agriculture.

The variable *POPULATION* indicates that larger countries host significantly more certified enterprises. Depending on the underlying estimator the effect ranges from 0.004 to 0.02 additional certificates per one million additional inhabitants in the case of BRC and from 0.04 to 0.05 in the case of GlobalGAP. The result might appear somewhat tautologically. However, the estimated negative coefficient in the zero-inflation part of the NB model points to a higher probability of non-certification in smaller countries. Similarly, the variable enters

the variance function of the generalised NB model with a negative sign. Estimated coefficients are statistically significant in both models in the case of GlobalGAP. We conclude that producers in smaller countries might represent a less interesting source for retailers due to a smaller supply base.

Among the variables capturing infrastructure conditions, the existence of a domestic accredited auditor's headquarter (*AUDIT*) has a highly significant impact.¹⁷ Countries with at least one auditor are predicted to have 118 - 138 more GlobalGAP and 15 - 19 more BRC certificates. Full participation by a country in the International Organisation of Standardisation (*ISO*) shows a statistically significant effect regarding GlobalGAP certification. Full ISO membership reduces the probability of non-certification and the variance of the dependent variable. Thus a government's participation in the international development of public standards has also a positive effect on the access of producers to private standards. The effect is very likely to work indirectly via a harmonisation of the standard setting environment and the presence of the required infrastructure like metrology bodies.

Surprisingly, the coefficients of variables in the group sectoral characteristics explaining the number of BRC certificates are smaller and lack statistical significance with one exception. In the case of GlobalGAP, most of them are highly statistically significant and, additionally, show quite high quantitative impacts. In contrast with expectations, countries with a higher share of exports and imports relative to their GDP display a lower number of certified farms. One explanation could be that the value of exports and imports is driven by the relative weight of more expensive manufactured products in a country's trade portfolio. A statistically significant impact of the size of the net agricultural exports (*NETXPAG*) on the number of issued certificates is only suggested by the zero-inflated NB model with respect to

¹⁷ One can be suspicious about the endogeneity of *AUDIT*. Having an auditor in the country can be the result of having standards as opposed to explain the number of food standards. However, we argue that certification without an auditor in the country is not impossible as auditors from another country are available.

GlobalGAP. Much more important seems to be the trade relation with the respective Western European countries. Except in the zero-inflated NB model explaining BRC certificates, this variable's coefficient is equally large and statistically significant for GlobalGAP as well as for BRC. A similar relation has been found by Neumayer and Perkins (2005) who use the combined value of exports to the EU countries and Japan relative to the exporting country's GDP in their analysis of ISO 9000 certification. The highest quantitative impact is predicted for GlobalGAP in the zero-inflated NB model to reach 20 certificates by an increase of the trade share by 10 percentage points. Furthermore, we can state that the estimated coefficient of the variable *FVPRODpac* indicates a significant positive impact of production of fruit and vegetables in a certain country on the number of GlobalGAP certified farms in that country. As GlobalGAP started with standards for fresh vegetables this relationship was expected. Probably, the results highlight the targeting of certification on countries with a specialised or intense production of fruits and vegetables or a more beneficial cost-benefit relation for fruits and vegetables producers. However, there is no significant impact of fruits and vegetables production in the BRC estimation.

The estimated coefficient of the variable *RULELAW* underlines the importance of the quality of institutions. Hence, a better institutional environment helps firms to take advantage of modern organisational innovations.¹⁸ Comparing the coefficients for BRC and for GlobalGAP in the different parts of the models reveals that institutional quality seems to affect within-country diffusion in the case of GlobalGAP. However, in the case of the BRC standard the variance of the dependent variable decreases with an increasing institutional indicator. The result is generally in line with Correa et al. (2008) who show evidence of a higher probability of ISO certification at firm level in countries with a better institutional quality analysing a sample of Central and Eastern Europe countries.

¹⁸ In order to further examine the impact of the institutional environment, the impact of bureaucracy indicators has also been tested. Results indicate that there is no significant impact of either an index reflecting the costs of trade or an index of regulatory quality in any of the models (results available upon request).

Finally, the GDP per capita variable and the squared GDP per capita variable display a quadratic impact on the number of certified firms in a country for both standards. However, the impact is much lower in the case of BRC and lacks statistical significance. Hence, the number of GlobalGAP certificates is predicted to increase up to a GDP per capita between 1140 and 1400 US-\$ and decreases thereafter conditionally on all other explanatory variables. One possible extension of the econometric analysis would be the inclusion of lagged numbers of certificates or even the estimation as panel. Unfortunately, data of previous years are currently not available.

Conclusions

The present study empirically analyses the global spread of retailer driven food standards and possible determinants using aggregated cross-country level data from GlobalGAP and BRC of 2007. Four classes of explanatory variables including historical and geographical characteristics, infrastructure conditions, sectoral and institutional characteristics as well as GDP per capita are used to explain the number of certified suppliers per country. The results of two different negative binomial models, a zero-inflated NB and a generalised NB, reveal distinctive differences between the two standards.

Our analysis proves the significant impact of macroeconomic determinants on the aggregated adoption of retailers' standards. There is evidence that certification at country level is not a random process but is influenced by many different historical, macroeconomic and institutional determinants.

Our results show no evidence that developing countries are excluded from retailer driven food standards *per se*. However, in the case of GlobalGAP GDP per capita is shown to be positively correlated with the number of issued certificates. Smaller countries seem to have a lower probability to have any farm certified. Furthermore, farmers' participation in

organisational innovation is negatively affected by a poor institutional quality of their country as indicated by the negative estimate of the variable rule of law. The final and the most important finding shows that certification is highly influenced by previous trade relationships. Taking these findings together, there seem to be potential barriers for farmers and firms in developing countries to establish new markets via Western European supermarkets. Especially producers in countries which have less intense or no trade relations with Western European countries might face increasing barriers. Subsequently, sourcing of retailers might concentrate on the sub-sample of countries which already delivers the largest share of agricultural and food imports.

In this framework, we are not looking at the effect of increasing demand for certified supplies by others than those of German, Dutch and British retailers. However, it seems reasonable to assume that the broadening participation of supermarkets within Western Europe in GlobalGAP and other initiatives will affect supplier-retailer relationships in an increasing number of countries.

Our approach faces two limitations. First, firms comply with standards and not countries. However, analysing firm-level adoption from a cross-country perspective faces various barriers. The costs and benefits of a certain technology's adoption are relatively easy to quantify in monetary terms. With respect to standards, various potential benefits like improved market access to certain distribution channels, improvements of internal processes or higher stability of supplier-customer relationships are more difficult to quantify. Especially compliance costs are, obviously, much more producer specific compared to the purchase of a certain technology. Private standards complement importing countries' national and European public regulation. Therefore, producers in countries with already higher food quality and safety requirements might face lower compliance costs than producers in countries with less stringent public regulation. Up till now, there is no consensus in the literature under which

circumstances benefits of adoption outweigh compliance and certification costs. Thus, at this point this cannot be operationalized for analysis.

The second limitation of our analysis is lacking possibility to derive any conclusions about distributional effects within countries. Subsequently, the appropriate level of analysis would be to use firm-level data. However, those are not publicly available and surveys in every country would not be feasible. The same data problem applies to the produced output under certification which would give a better indication of the standard's economic importance within a country's agricultural and food sector.

Overall, our study of current cross-national adoption's determinants holds important implications for future research. It remains to be analysed whether a bifurcation of the market exists by observing what determines the certification process within countries at farm/firm-level. Most recently, results by Maertens and Swinnen (2009) point to changes in organisational structures in developing countries' export production. Furthermore, financial support of farmers and firms from exporters to obtain certificates in some cases or even the joint certification of a group of farmers via a cooperative might lead to heterogeneous individual adoption behaviour. Finally, Fulponi (2007) reports evidence of retailer's retreat on certification due to established personal trade relations or lack of adequate suppliers. Thus, the existence of any effective demand for certification from exporters within countries and its impact on adoption behaviour will have to be analysed further.

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Table 1: Descriptive statistics and sources of variables (N = 188)

Variable	Description	Mean	Source
<i>Dependent variables</i>			
GAP	Country has at least one certified producer under GlobalGAP standard	0.452	GlobalGAP
GAP-NO	Number of certified producers of GlobalGAP	378.950	GlobalGAP
BRC	Country has at least one certified producer under BRC Food Technical Standard	0.436	BRC
BRC-NO	Number of certified producers of BRC Food Technical Standard	38.130	BRC
<i>Historical and geographical conditions</i>			
COLONY	Former UK colony (BRC) or former colony of D, NL or UK (GlobalGAP) [1 - yes, 0 - no]	(BRC) 0.298 (GAP) 0.356	CIA
POP	Population in million	34.036	World Bank, CIA
<i>Infrastructure conditions</i>			
ROAD	Length of roads per km ²	0.680	World Bank, CIA
AUDIT	Existence of domestic auditor [1 - yes, 0 - no]	(BRC) 0.383 (GAP) 0.154	GlobalGAP, BRC
ISOM	Full ISO membership	0.564	ISO
WWW	Number of internet subscribers per 100 inhabitants	17.470	World Bank
<i>Trade/ customer requirements</i>			
OPEN	Share of exports and imports on GDP [%]	83.121	World Bank
AXSHARE	Share of agricultural exports on total exports [%]	21.581	FAO, UN
NETEXPAG	Value of net agricultural exports [Mio.US-\$]	0.023	FAO
TRADESHARE	Share of agricultural exports to UK (BRC) or to D, NL and UK (GlobalGAP) on total agricultural exports [%]	(BRC) 6.884 (GAP) 15.810	UN
FVPRODpac	Fruit and vegetable production [1000 kg per agricultural population]	1.830	FAO
<i>Institutional quality and GDP per capita</i>			
LAW	Rule of law [0 - low level of rule of law, 10 - high level]	4.828	Kaufmann et al. (2007)
LGDPpc	Log of GDP per capita	7.692	World Bank, CIA
LGDPpc2	Log of GDP per capita squared	61.743	World Bank, CIA

Table2: Distribution of GlobalGAP and BRC certified producers worldwide

	Europe	America	Oceania	Asia	Africa	World
Number of countries	44	36	14	45	53	192
GlobalGAP						
Countries with certification	31	19	2	14	19	85
Share of countries	70.45	52.78	14.29	31.11	35.85	44.27
Number of certificates	56558	6272	1993	3044	3375	71242
Share of total certificates	79.39	8.80	2.80	4.27	4.74	
BRC Food Technical Standard						
Countries with certification	36	13	2	19	13	83
Share of countries	81.82	36.11	14.29	44.44	24.53	34.90
Number of certificates	6085	167	155	566	197	7170
Share of total certificates	84.87	2.33	2.16	7.89	2.75	

Note: Only internationally recognised countries included.

Table 3: Results of specification tests

	GlobalGAP	BRC
Overdispersion ($\Gamma = 0$) (constant only)	299034.40 ***	16981.04 ***
Overdispersion ($\Gamma = 0$) (conditional level)	54174.74 ***	5561.70 ***
Overdispersion ($\Gamma = 0$) (conditional level and zero inflation)	28744.19 ***	3473.17 ***
Vuong test of zero inflation	1.98 **	1.71 **

Note: The overdispersion tests base on a likelihood-ratio test following a χ^2 distribution. The Vuong test compares a zero-inflated negative binomial model with a standard negative binomial model equally based on a likelihood-ratio test statistic.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4a: Determinants of cross-national spread of GlobalGAP certificates

Dependent variable	Zero-inflated NB		Generalized NB	
	NB	Zero-inflation	NB	Variance
<i>Historical and geographical conditions</i>				
COLONY	-1.706 *** (-3.74)	-0.343 (-0.40)	-1.486 *** (-3.19)	0.292 (0.90)
POPULATION	0.001 ** (2.06)	-0.376 *** (-3.13)	0.001 *** (2.99)	-0.011 *** (-3.69)
<i>Infrastructure conditions</i>				
ROAD	-0.138 (-0.77)		-0.099 (-0.93)	
AUDIT	1.805 *** (4.49)		1.947 *** (4.38)	
ISOM		-1.779 ** (-2.19)		-1.507 *** (-3.46)
WWW	0.007 (0.38)	-0.037 (-1.34)	0.012 (0.60)	-0.005 (-0.50)
<i>Trade/ customer requirements</i>				
OPEN	-1.840 *** (-3.73)		-1.713 *** (-3.61)	
AXSHARE	0.371 (0.32)		1.489 (0.93)	
NETXPAG	0.161 ** (2.04)		0.033 (0.66)	
TRADESHARE	5.802 *** (4.20)		5.564 *** (3.65)	
FVPRODpac	0.367 *** (5.20)		0.329 *** (7.41)	
<i>Institutional quality and GDP per capita</i>				
LAW	0.771 *** (4.30)	-0.076 (-0.30)	0.779 *** (4.51)	-0.172 (-1.62)
LGDPpc	8.178 *** (6.08)		9.458 *** (8.18)	
LGDPpc ²	-0.581 *** (-6.42)		-0.653 *** (-8.59)	
Constant	-27.078 *** (-5.09)	3.720 *** (2.64)	-33.237 *** (-7.07)	4.149 *** (6.83)
r	3.262			
N	179	97 (y = 0)	179	
Pseudo R2	0.121		0.090	
Wald chi ² (df)	215.79 (13)***		136484 (13)***	

Note: z-values are displayed in parentheses and base on heteroscedasticity consistent standard errors.

*** p<0.01, ** p<0.05, * p<0.1. COLONY refers to former colony of either Germany, the Netherlands or UK. TRADESHARE refers to the sum of exports to Germany, the Netherlands and UK over total agricultural and food exports.

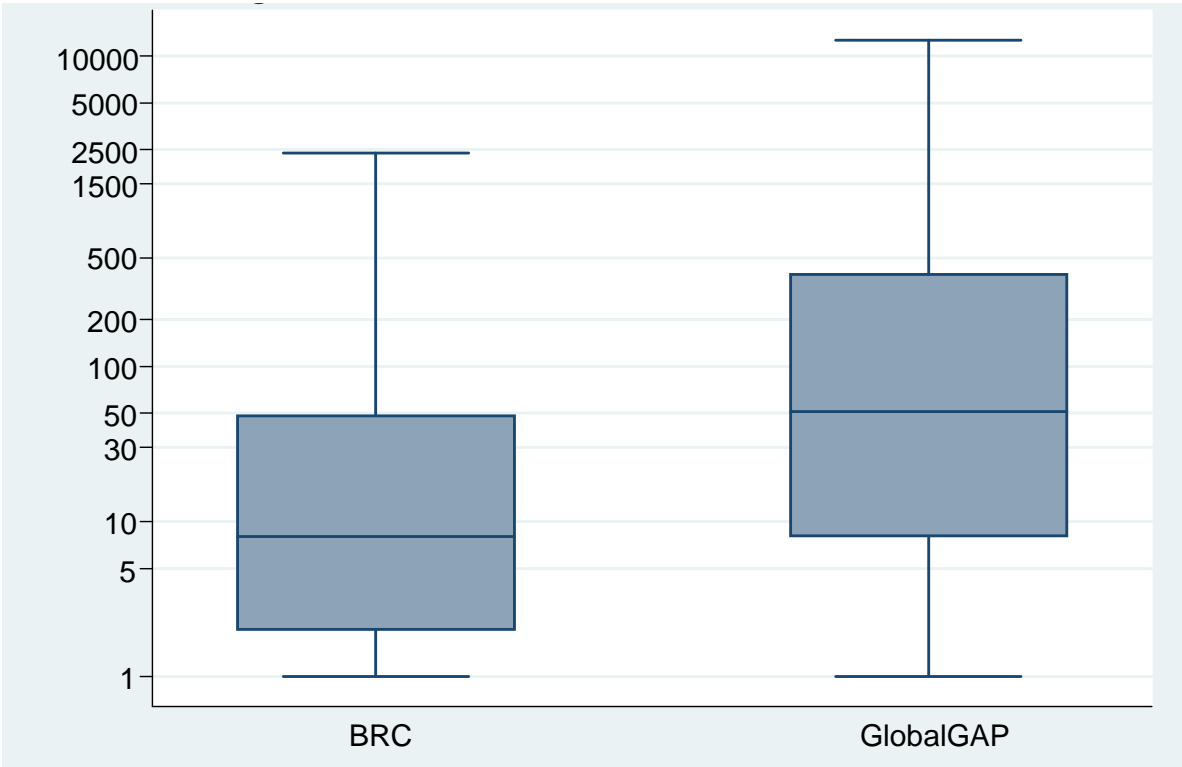
Table 4b: Determinants of cross-national spread of BRC certificates

Dependent variable	Zero-inflated NB		Generalized NB	
	NB	Zero-inflation	NB	Variance
<i>Historical and geographical conditions</i>				
COLONY	0.094 (0.14)	0.705 (0.11)	-0.606 (-1.06)	0.586 (1.34)
POPULATION	0.002 *** (3.08)	-0.019 (-0.34)	0.002 *** (4.02)	-0.006 *** (-3.73)
<i>Infrastructure conditions</i>				
ROAD	0.300 (0.35)		0.074 (0.36)	
AUDIT	3.023 *** (2.20)		3.401 *** (7.54)	
ISOM		-2.201 (-1.21)		-1.244 (-1.62)
WWW	0.013 (0.22)	0.026 (0.44)	0.035 * (1.83)	0.042 *** (3.38)
<i>Trade/ customer requirements</i>				
OPEN	-1.184 (-1.33)		-0.571 (-1.17)	
AXSHARE	-0.626 (-0.26)		-1.998 (-1.37)	
NETXPAG	0.101 (0.96)		-0.010 (-0.22)	
TRADESHARE	2.780 (0.18)		5.425 * (1.68)	
FVPRODpac	0.042 (0.29)		0.061 (0.90)	
<i>Institutional quality and GDP per capita</i>				
LAW	-0.008 (-0.02)	-0.912 (-0.66)	0.020 (0.08)	-0.639 *** (-4.82)
LGDPpc	-0.498 (-0.06)		2.395 (1.62)	
LGDPpc2	0.046 (0.09)		-0.144 (-1.41)	
Constant	1.137 (0.04)	4.423 (0.70)	-10.167 * (-1.74)	4.597 *** (5.51)
r1	1.583			
N	181	100 (y = 0)	181	
Pseudo R2	0.191		0.116	
Wald chi ² (df)	220.99 (13)***		640.87 (13)***	

Note: z-values are displayed in parentheses and base on heteroscedasticity consistent standard errors.

*** p<0.01, ** p<0.05, * p<0.1. COLONY refers to former colony of the UK. TRADESHARE refers to the sum of exports to the UK over total agricultural and food exports.

Figure 1: Distribution of certificates per country



Appendix

Table A 1: Comparison of different estimation approaches to explain the number of certificates

Standard	Estimation approach	Log-likelihood	Overdispersion parameter α	AIC
GlobalGAP	Negative Binomial (NB)	-583.06	6.74	1196.13
	Hurdle NB	-557.73	2.89	1172.30
	Generalised NB	-551.88	-	1143.75
	Zero-inflated NB	-555.77	3.26	1153.54
	Negative Binomial (NB)	-394.75	2.39	819.50
BRC	Hurdle NB	-385.79	2.21	820.44
	Generalised NB	-382.29	-	804.58
	Zero-inflated NB	-385.35	1.58	812.69

Figure A1: Distribution of GlobalGAP certificates over countries

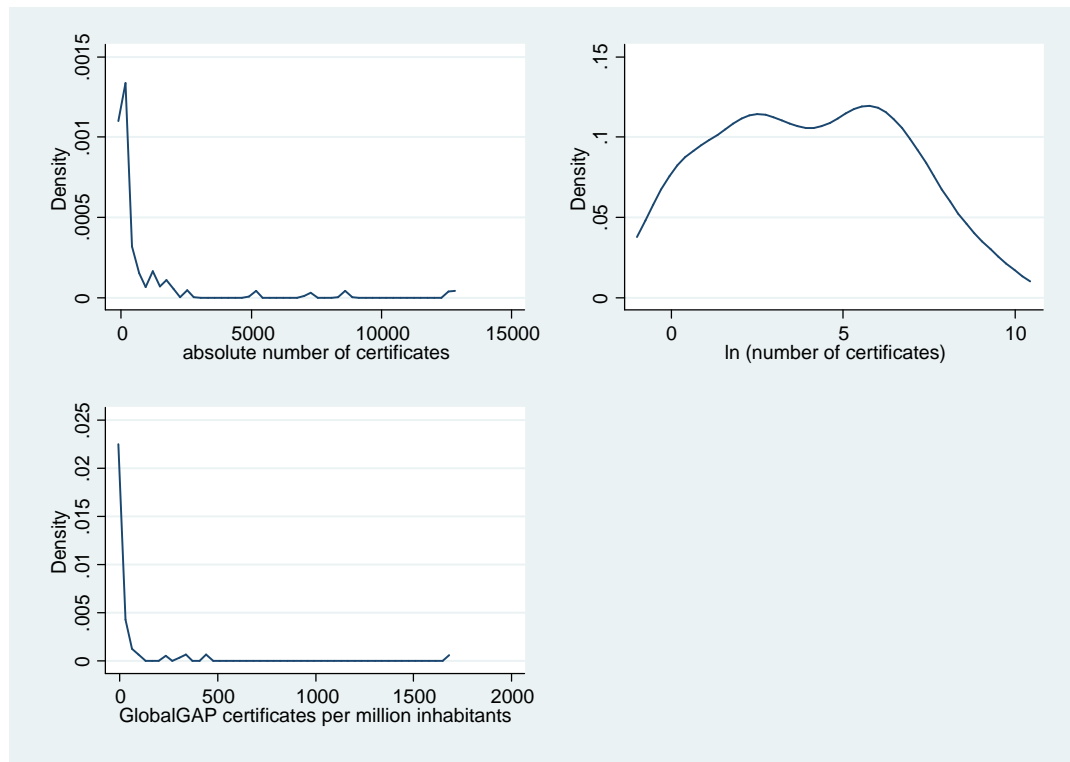


Figure A2: Distribution of BRC certificates over countries

