CHARLES UNIVERSITY IN PRAGUE

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Master thesis

The Impacts of Non-Tariff Measures on China's Tea Exports

Author: Ling Liu

Supervisor: Vilém Semerák, Ph.D..

Academic Year: 2020/2021

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague … Jan 5, 2021 Ling liu

Abstract

Tea is China's traditional export-earning agricultural product. For a long time, China's tea exports have occupied an extremely important position in the international market. With the further opening of the international agricultural product market and the increasingly fierce competition in the international tea market, China's tea exports are increasingly being affected by technical barriers.The purpose of this paper is to empirically analyze which factors are affecting Chinese green tea exports. In addition, there is a focus on the trade status of Chinese green tea in the EU market, Japan and the United States.

To achieve this objective, this paper adopts a modern approach to gravity models, i.e. an approach which uses specifications based on micro-foundations. Specifically, The paper uses a specification which explicitly takes into account the nature of multilateral trade resistance (MTR). More specifically, estimators based on traditional panel methods (combined with the recommended structures of dummies) and Silva-Tenreyro’s (2006) PPML estimator (also combined with dummies).

The results show that the maximum residue limits(MRL) of pesticides in importing countries have significantly impacted the export of Chinese tea. The cultural effects such as the Language similarity have a positive impact on China’s green tea exports.

Finally, this paper makes policy recommendations to further improve the formulation of China's MRT standards and establish a pesticide evaluation system in line with international standards.

Keywords —Pesticide residue limit; Tea export; Gravity model

Contents

List of Figures..VII

List of Tables...VIII

Master Thesis Proposal..

1.Introduction..**1**
2. Literature Review..**3**
2.1 The gravity model..**4**
2.1.1. A brief history of the gravity model 4
2.1.2 Micro-foundations..6
2.2 General issues and solution on gravity model...7
2.2.1 Specification issue..7
2.2.1 Three possible proxies for MRT...8
2.2.2.Three common errors: Gold, silver, bronze..8
2.2.3 Some other issues: Zero trade flows and heteroskedasticity 9
2.2.4 Poisson pseudo maximum likelihood (PPML)..10
2.2.5 Monte Carlo evaluation of gravity model estimators...10
2.3 Recent literature of gravity models...**11**
2.3.1 The application of gravity model on Agriculture trade..11
2.3.2 Recent Literature on gravity models regarding Chinesetrade..11
2.4 What are non-tariff measures?..**12**
2.5 Literature on non-tariff measures affecting China's tea exports **12**
2.5.1 The effects of pesticide standards on Chinese agriculture trade....................................13
2.5.2 Gravity model & tea trade results table...15
2.5.3 Literature on Chinese tea culture 17
3.Descriptive part **18**
3.1 Analysis on the total volume of world green tea exports and proportion 18
3.2 Total volume of world green tea imports and proportion...19
3.3 EU green tea imports in recent years 20
3.4 Review of China's tea exports..22
4. Data and Methodology...**27**
4.1.1 Original data descriptive statistics and testing..32
4.1.2 Methodology...36
5. Estimation Results..**50**
6. Conclusion **53**

Bibliography (References).....54.

Appendix ....

List of Figures

Figure 1: Total volume of world green tea exports and proportion 2018 19
Figure 2: Total volume of world green tea imports and proportion 20
Figure 3: Total volume and proportion of EU green tea imports 21
Figure 4: Leading eight importing countries in Europe 22
Figure 5: International comparison of green tea export price...27
Figure 6: Tea-etymology map 31

List of Tables

Table 1: Gravity model & Tea trade results table 15
Table 2: Where does China export green tea? (2018)..23
Table 3: World's major tea exporting countries 25
Table 4: Summary of variables used in the basic gravity model...28
Table 5: The MRLs of 3 major pesticides...29
Table 6: Summary of variables 32
Table 7: The correlation between variables...33
Table 8: Dataset of original trade data and merged data...36
Table 9: Estimation methods 37
Table 10: The observations and regression results of tea export value without non-tariff 39

Table 11: Merging with importing countries that implement pesticide standards...............41
Table 12: The observations and regression results of tea export value with non-tariff........42
Table 13: Results of tea export value with non-tariff measures (tea_etymology)...............44
Table 14: Regression results of Basic traditional gravity model (pooled OLS)..................48
Table 15: Summary of the results of the above three perspectives....................................48

Master's Thesis Proposal

Charles University

Institute of Economic Studies

Faculty of Social Sciences

Author:	**Ling Liu**	Supervisor:	Ing. Vilém Semerák M.A., Ph.D..
E-mail:	51137691@fsv.cuni.cz	E-mail:	vilem.semerak@gmail.com
Phone:	773197123	Phone:	608152261
Specialization:	MEF	Defense Planned:	September 2020

Proposed Topic:

The Impacts of Non-Tariff Measures on China's Tea Exports

Hints: Which and how much countries will be analyzed in the paper is determined by the efficiency and availability of data

Motivation:

The trend toward an increasingly globalized economy supports the spread of the food culture of foreign countries.Chinese tea is a traditional commodity that is characteristic of Chinese culture. Diverging from previous research, this paper approaches the problem from the perspective of culture between exporting and importing countries. It applies a gravity model to empirically quantify the effects of "tea etymology" between China and its importing countries on China's green tea export. The results attribute China's tea exports to the dual connotation of "going out" in the Chinese economy and culture.

At present, China ranks first in terms of tea planting area and total production, and exports tea to more than 40 countries and regions every year. Exports are largely to African, European and North American markets. Although the EU and Japan are significant consumers of tea, the export volume of Chinese tea is relatively small in these markets. There are two possible reasons for this.

The first possible reason as to why Chinese tea imports are lower in the EU concerns the thick technical barrier; and the second reason relates to the influence of market competition between China and other emerging tea-producing countries. Understanding of the EU pesticide residue limit regulations and analyzing the impact on China's tea trade after implementation, demonstrates certain practical significance for the continuous growth of China's tea trade. Additionally, the analysis of regulations provides insight for safeguarding the interests of tea enterprises and tea farmers, and generates suggestions as to how to promote China's tea exports. The second reason will be briefly explained in the description part of the paper, but is not a major focus of this study..

The aim of this paper is to use the Gravity model to empirically analyze which factors are affecting tea exports generally. The objective is to study how specific trade barriers such as pesticide residue limit regulations impact China's tea exports to the EU,and carefully study specific trade barriers (such as pesticide residues) to identify targeted trade policies in the future. Moreover, this paper will also propose   relevant suggestions and positive measures that could promote China's tea exports.

Hypotheses:

Hypothesis #1: Technical barriers have a significant negative impact on tea exports.

Hypothesis #2: The pesticide residue regulation in particular has a significant negative impact on China's tea exports.

Hypothesis #3: The effect of technical barriers is particularly strong in the case of Chinese tea exports to the EU markets.

Methodology:

To test these hypotheses I use a modern approach to gravity models, i.e., an approach which uses specifications based on micro-foundations. Specifically, I will use a specification which explicitly takes into account the nature of the multilateral trade resistance (MTR).

I will use estimators which attempt to avoid the main problems (gold, silver, and bronze medal errors as defined in Baldwin & Taglioni, 2006). The three common errors can be dealt with using time-varying country dummies and time-invariant pair dummies. More specifically, estimators based on traditional panel methods (combined with the recommended structures of dummies) and Silva-Tenreyro's (2006) PPML estimator (also combined with dummies).

In addition to the gravity model, a descriptive analysis of the unit value of tea market transactions will form part of this paper, which aims to assess how prices affect Chinese tea exports.

Data will be obtained from various sources (except UN COMTRADE). the BACI data is at 6-digit product dis-aggregation ,which will greatly expand the number of countries/regions where trade data is available compared to the original data set.

Tea bilateral trade flows are predicted using the following Equation (1):

LnXij=0+1LnYit+2lnYjt+3lndijt+4lncontig +5lncomlang_+6lncomcoll+7lnendo +8lnfen +9lnflucy+9lnteaetymology..+εit .

where β is the parameter; *Xij*,represents the exports from country i to j; *yit* and *yjt* represent the economic size of country i and j, respectively as measured in GDP; d*ij* indicates the distance between the two economies, which is not a static concept;*Combor* is a dummy variable for countries that share a common border; *Comlang* is for countries having a common official language, *Comcol* describes the colonial relationship between two countries, *comcol* is a dummy variable for countries that were colonized by the same country;*Pestic* describes one type of particular barrier between Chinese tea exports and other Countries;*and Tea Etymology* is a dummy variable for countries having a tea etymology.

There are three main steps to conduct this analysis:

1.Estimate coefficients of the gravity model.

2.Use the gravity model to estimate the specific effect of particular barriers (especially for the EU markets) in the world.

3.Estimate the specific effect of particular barriers (pesticides) and tea etymology on the Chinese tea exports (?analysis together or respectively).

Expected Contribution:

This paper will provide four main contributions to the literature. .

First, I will demonstrate a better use of gravity methodology(Baldwin & Taglioni, 2006) from a microeconomic and statistical theoretical perspective and use MTR to avoid the three common errors (gold, silver and bronze medal errors) in the previous literature.

Second, I will use the latest data from the BACI to extend considerably the number of countries for which trade data are available to ensure its relevance.

Third, I expect to obtain estimates of the specific and comprehensive standards on Chinese tea exports in different countries.

Finally,a dummy variable for countries having a tea etymology will be used to empirically study how it will influence the Chinese tea export from a cultural perspective.

The estimates can show trends in trade relations, which can then be used to predict future trade developments.

Outline:

1. Introduction

2. Literature Review
3. Descriptive part
4. Data and Methodology
5. Estimation Results
6. Conclusion
7. References

Core Bibliography:

Baldwin, R. & D. Taglioni. (2006). "Gravity for dummies and dummies for gravity equations." NBER Working Paper Series.

Fouquin, M. & J. Hugot. (2006). "Two centuries of bilateral trade and gravity data: 1827-2014." Universidad Javeriana-Bogotá.

Guo-da, G. (2007). “Empirical study on the impacts of technical barriers to trade on international trade[J]” *Journal of International Trade, 6.*

Silva, J.M.C. M. Caravana Santos & S. Tenreyro. (2003). "The log of gravity." SSRN Electronic Journal 88(4): pp.641-658.

Brakman, S. & P. A. G. Bergeijk. (2015). The gravity model in international trade advances and applications. Cambridge University Press. ISBN 978-0-521-19615-4

…..

Author **Supervisor**

Section 1

Introduction

Although there are many factors that may affect China's agricultural exports, policy makers (MOFCOM, 2009, pp. 111–124) and some scholars (Chen et al., 2008; Dong & Jensen, 2004) have identified food safety standards as one of the main barriers affecting China's agricultural exports.

This shift may have a wide range of potential impacts on exporters (Otsuki et al., 2001). For example, recent studies have shown that food safety standards have severely affected the export of agricultural products from developing countries to developed countries (Disdier et al.,, 2008).

In the green tea trade, pesticide residue limit is one of the greatest environmental trade barriers. The United States has continuously increased market access standards for imported tea, such as continuously reducing the maximum pesticide residues levels. Gu et al. (2007) find that pesticide residue is the main factor restricting the export of Chinese tea to Japan (the main destination of Chinese tea). The European Union (EU) has also newly issued the pesticide residue limit indicator, expanded the scope of inspection, and issued a series of management regulations[1].

Sun et al. (2007) calculated the cost of pesticides and showed that the change of maximal residual limits (MRLs) in the EU in 2003 increased the production cost of Chinese tea and reduced the export of Chinese tea to the EU.

[1] Annexes II and III to Regulation (EC) No 396/2005

Wei et al. (2012) evaluate the impact of the maximum residue limits imposed by importers on China's tea exports, and conclude that a 1% stricter foreign maximum residue limits on endosulfan and cystethrin would reduce China's tea exports by 22%.

In some cases, due to food safety standards, Chinese agricultural products are actually banned from importing in some countries. For example, the Cezch Republic banned the import of green tea from China in November 2020 because of concerns over pesticide residues.[2]

China is the world's largest tea producer, and its annual output in recent years has accounted for about one-third of the world's tea (FAO, 2010). China was also the second largest tea exporter in 2018 (OEC, 2018). Chinese producers would rather export to the EU than elsewhere, because both the relative price of tea and the profit margins are higher [3](Wang et al., 2018).

However, there is increasing evidence that the tea safety standards of importing countries have been strengthened, while the overall tariff rates of tea imports have fallen (Chen, 2004, 2007). Are these effects also affecting China's tea exports? Specifically, what major food safety standards will affect China's tea exports, and how do these standards affect China's tea exports?

The purpose of this paper is to assess the impact of food safety standards on Chinese tea exports empirically and provide answers to the above questions. This goal can be achieved by understanding the EU pesticide residue limit regulations and analyzing the impact of their implementation on the trade of Chinese green tea, and putting forward suggestions as to how to promote China's tea exports. This will have certain practical significance for the continuous growth of China's green tea trade and the interests of tea companies and farmers.

Although there is increasing concern about the impact of food safety standards on China's agricultural exports, few empirical studies have investigated this important issue.

Moreover, Data and empirical analysis on the impact of non-tariff measures on the trade of green tea in China are still lacking.In this regard, this study aims to provide an empirical analysis of how non-tariff measures affect the international trade volume and to predict future

[2] https://www.szpi.gov.cz/en/article/cafia-banned-300-kg-of-green-tea-with-insecticide-permethrin-content-five-times-higher-than-the-limit.aspx

[3] Analysis of the Impact of EU Pesticide Residue limit Barriers on Chinese Tea Export

changes in green tea trade patterns. This study uses the extended gravity model to conduct an empirical analysis of the EU's largest tea pesticide residue standard and its impact on two-way green tea trade volume.

To achieve the above objectives, the rest of this paper is arranged as follows: Section 2 summarizes the relevant literature and divides it into two main parts, literature on the gravity model and literature on non-tariff measures (NTMs).The first part briefly introduces the historical development of the gravity model and the issues it faced during its evolution, and then introduces the latest literature on methodology. The second part reviews empirical evidence on the effects of NTMs on global agriculture trade and China's tea exports.

Section 3 presents the status quo of green tea imports and exports in the world, including the EU and other major countries, and the dynamic changes in recent years (1995 to 2018) to achieve the following two analysis goals: First, to speculate on the target sales market of green tea exports in the future by observing import dynamics such as upward trends, and second, to observe the specific years in which China's green tea exports declined, and to put forward speculations about the factors that may cause changes in China's exports.

Section 4 is divided into two main parts: The first part briefly discusses the data sources used in empirical estimation. The second develops an empirical model based on a gravity equation to assess the effect of non-tariff measures adopted by the importers of tea and discusses changes for tea safety standards indicated by MRL of pesticides (e.g., endosulfan, fenvalerate, and flucythrinate) in importing countries. An empirical model based on a gravity equation to assess the effects of “tea Etymology” on China’s green tea export is also provided in this section.

Section 5 discusses the regression results of econometric estimations and summarizes the results of individual models and methods.

The final section of the paper draws conclusions and proposes suggestions for promoting green tea exports from the perspective of non-tariff measures and culture.

Section 2

Literature review

This section summarizes the existing literature on gravity models and non-tariff measures, and consists of two parts.

The first part introduces the evolution process of the gravitational equation in the econometric model of international trade. Following, it describes the difficulties encountered in the evolution of the gravity model and the corresponding improvements and the latest research.

Then, the second part introduces the literature on non-tariff measures.There are several studies showing that non-tariff measures have a negative impact on tea exports, indicating the challenges tea exporting countries have following the introduction of food safety standards.

Finally, this paper explores the cultural aspect of tea. It examines the importance of cultural effects in promoting the export of Chinese tea in the world from both a theoretical and empirical research aspective.

2.1 The Gravity model

2.1.1 A brief introduction to the evolution of the gravity model

The Gravity model appeared in the 1960s as a useful analytical tool for international trade analysis. The gravity model takes its name from Newton's law of universal gravitation.

(Kerr & Gaisford, 2007). Newton’s law of universal gravitation states that all particles are attracted to each other. This force of this attraction is proportional to the product of the particles mass, and inversely proportional to the squared distance between the centers of the particles (Newton, 1999).

Tinbergen (1962) provides seminal work on the gravity model and applies it to the econometric study of the international trade (Kerr & Gaisford, 2007). The inspiration by physics is evident; In 1929, he received a doctorate in physics under the guidance of Paul Ehrenfest, a close friend of Albert Einstein, with the dissertation title "Minimum Problems in Physics and Economics" (Szenberg, 1992, p. 276; Leen, 2004).

Tinbergen’s application to trade flows assumed that the extent of a trade flow be positively related to the economic scale of the trading partners and negatively correlated with the distance between them.In economic research the gravity model has has been used in various fields and has become the basic equation of international trade research since its formulation by Tinbergen.Economists have used it to model bilateral trade data in empirical work. There were some reasons for its success. The form is simple and the model has fairly good predictive power, i.e. the ability to estimate bilateral trade flows relatively accurately (Leamer & Levinsohn, 1995).

Ever since Tinbergen (1962), economists have been estimating the gravity equation based on bilateral trade data, and the gravity model has achieved great success in empirical work. However, it was also criticized for lacking the solid theoretical foundation that economists deemed necessary.Critics remarked that the gravity equation is more similar to a physical analogy than a reliable economic analysis based on the micro-foundation (Head and Mayer , 2013) .

However, other researchers continue to try to put forward the theoretical foundations of the gravity model. Anderson (1979) was perhaps the first to attempt to provide a theoretical basis for a gravity model.His theoretical framework is based on the assumption that commodities are differentiated by country of origin. Anderson and van Wincoop’s theoretical foundation attempts are considered by Leamer and Levinsohn (1995, fn. 13) to be too complicated for daily use.

The year 1995 was a very important turning point for the gravity model. Head and Mayer (2013) recognize the gravity model as entering the "admission" stage in 1995.

Since 1995, various theories have been developed to build the theoretical basis for the gravity model. There were several important breakthroughs for the barriers that had prevented the gravity model from becoming more widely accepted. Head and Mayer (2013) consider it to be an important part of international trade, and identify 2002-2004 and 2008 as the other two stages of gravity model development, where researchers started to realize the “missing trade” existed and attempted to adopt gravity as a way to measure and explain it.In 1995, Trefler proposed the so-called "missing trade ". Krugman (1995) believes that “remoteness” could affect trade and provided insight as to why the multilateral resistance terms proposed by Anderson (1979) are needed.

Before 1995, the business press proclaimed the “borderless world” and “the death of border”

(Head & Mayer, 2013). McCallum (1995) refutes the view that national borders had lost their economic relevance, and published a paper that attends to understand "border effects." However, McCallum's estimates of the border effect are extremely high. Anderson & van Wincoop (2003) showed that the estimates are biased and they decrease (but are still significant) when estimated properly. They believe that the McCallum (1995) model ignores the multilateral resistance variable, thereby expanding the "border effect." Therefore, the famous "McCallum border puzzle" and the conventional critique of the absence of the solid theoretical foundations are resolved in their paper, which is one of the most cited papers about the gravity methodology.

The second period (2002-2004) included the development of the multilateral resistance term (MRT). MRT a bilateral trade resistance,a trade barrier between two countries, and also a trade barrier faced by each country and all trading partners (Anderson & van Wincoop 2003).[1]Redding and Venables (2004) point out that the fixed effects of importers and exporters have been used to estimate the MRT that appears in different theoretical models.

The combination of consistency with theory and ease of implementation led to the rapid adoption of the gravity equation in economic empirical work (Gopinath et al., 2014).

The final stage , and especially the year 2008, includes three papers by Chaney, Helpman et al., and Melitz and Ottaviano showing the "convergence" of the gravity and heterogeneous firm literature.

2.1.2 Micro-foundations

The above researchers show that, from an econometric theory perspective, the adequate specification and estimation method used in the model are the two crucial factors for drawing proper inferences from estimations.If the typical traditional gravity equation is mis-specified, this can lead to biased and frequently misinterpreted results. In order to provide a concrete example, I use a highly cited paper, Rose (2000) which is analyzed by Baldwin and Taglioni (2006). The regression estimate preferred by Rose (2000) is biased by omitted variables. In particular, the "unconstant gravitational force" (that is, multilateral trade resistance referred to byAnderson and van Wincoop (2003) is included in the regression residual.

This mis-specification leads to two bias problems. One of these problems is the gold medal of the classic gravity model error;[4]the gold medal error is the main cause of the problem - it means that the model is misspecified and therefore it may lead to biased estimated.(as confirmed in Baldwin & Taglioni, 2006).

Based on this issue, the researchers tried to provide a consistent theoretical foundation for the Gravity Model.

One of the main contributions for further work on the gravity equation is the paper by Anderson and van Wincoop (2003), where they derive a more practical gravity model with control for the elasticity of the substitution of expenditure system (full expenditure system):

$$Xni = \frac{Yi}{\Omega i}\frac{Xn}{\Phi n}\Phi ni \qquad (1)$$

where Ωi and Φn are "multilateral resistance" terms, defined as:

$$\Phi n = \sum_l \frac{\Phi nlYl}{\Omega l} \text{and } \Omega i = \sum_l \frac{\Phi liXl}{\Phi l} \qquad (2)$$

For a given set of trade costs, the terms Φ and Ω can be solved (Head & Mayer 2013).

Anderson and Wincoop's theoretical results show that bilateral trade does not only depend on absolute trade costs, that is, the tendency of country j to import from country i. It also depends on the overall "resistance" of country j relative to country i and the average "resistance" faced by exporters of country i against country i's trade costs.

These multilateral trade resistance (MTR) terms are defined as: the relations of each country in the pair with third countries that also matter or are crucial for a well-specified model. The original version was derived for cross-section data, but a panel version was later added by Baldwin & Taglioni (2006).

2.2 General issues and solutions for gravity models

[4] I will elaborate on page 13.

2.2.1 Specification issue (Three possible ways to deal with the MRT/ proxies for MRT)

The above theory by Anderson and van Wincoop (2003) not only provides the theoretical foundations for the Gravity model, but also highlights the severe bias which arises if MRT is not controlled for.

Unfortunately, correcting the gravity specification is not necessarily straightforward because of the features of the MRT – it is an abstract (and not directly observable) variable and its influence is assumed to be non-linear. Three practical solutions for dealing with the MRT have been developed.

The first traditional approach is to estimate the so called "price-raising effect" of multilateral trade barriers (Anderson & van Wincoop, 2003), although this procedure is very complicated, so it is not often used for estimation because the original theory requires non-linear least squares (NLS) (in fact it has been rarely followed). When using very large data sets, this method may also encounter computational difficulties, which is not uncommon in the case of gravity models (Head & Mayer, 2013). Moreover, the standard OLS specification will be easier to fit and interpret the estimated parameters.

The second method consists of proxying the effects of MRT by systems of dummy variables. Baldwin and Taglioni (2006) analyze the solutions[5] for panel data , showing time-varying national dummies can be used to deal with MRT, while the determinants of bilateral trade are dealt with by time-invariant dummies.

The third alternative, is called Bonus Vetus OLS and is proposed by Baier and Bergstrand (2009), who show how to use a linear approximation (with the aid of a first order Taylor series superposition) and transform the MRT into a simple linear relationship and estimate

[5] The original Anderson and van Wincoop was for cross-section

the resulting model (with additional theoretically-motivated exogenous MR terms) with the use of standard OLS.

2.2.2 Three common errors

Although papers based on gravity models were often published even before 1995, many of the older as well as some of the more recent applications are lacking. Baldwin and Taglioni (2006) show common errors which, if ignored, can lead to biased estimation and give unrealistic economic results on the final estimation. Baldwin and Taglioni (2006) make a very general derivation of the gravity model and point out the three most typical errors in the gravity model. They refer to these errors as gold, silver, and bronze errors, respectively.

The big problem (gold medal) is that the omitted terms that Anderson and van Wincoop call multilateral resistance terms are related to trade-cost terms. Therefore, the estimates are biased.

Silver medal mistakes occur because many researchers mistake the logarithm of the mean for the mean of the logarithms. To avoid this error, Baldwin and Taglioni (2006) recommend that the averaging should be done after taking logs. If someone uses only cross-section data, the silver medal mistake will be removed by using nation dummies.

The bronze medal mistake is related to incorrect conversion of the data based on the use of the general price indexes for the United States. Due to prevailing inflation trends, each bilateral trade flow is divided by the same price index, and such conversion may bring errors to the regression. Rose (2000) and other papers note that "time dummies" (Baldwin & Taglioni, 2006) will correct the mistaken deflation procedure for this error.

These errors are very important for empirical estimation of the gravity model and also remind researchers that the variables and estimation methods must be selected very carefully in order to get more significant results in future empirical estimation.

2.2.3 Some other issues: Zero trade flows and heteroskedasticity

In the estimation of the gravity model, a common and more important issue is the existence of zero trade flow in the data set, which is discussed by Burger et al. (2009) and Helpman et al. (2007).If there is no trade between the two countries in a given year, the trade flow of zero will occur.

Aside from this, the problem comes from the standard method of estimating the gravity model. which is to take the logarithm and estimate its log-linear version, because the zero logarithm is not defined, so zero trade flows will be excluded from the estimation (Martin & Pham, 2008).In particular, detailed trade data (such as the data on tea) are likely to include many zeros.

Another problem is that the ordinary least squares (OLS) model assumes that its econometric specification is log linear. When there is heteroscedasticity, biased results will occur in the conversion process.This is because Jensen's inequality means that $E(\ln y) \neq \ln E(y)$. In other words, the expected value of the log of a random variable is different from the expected value of the log of the expected value.

2.2.4 PPML (Poisson pseudo maximum likelihood)

After 2006, almost every paper at least considered or discussed the estimation method proposed by Santos Silva and Tenreyro (2006) as the most appropriate method. This is called the PPML method when it refers to their research, even if not directly applied. The paper by Arvis and Shepherd (2013) strongly demonstrates the results of Santos Silva and Tenreyro by highlighting the more ideal characteristics of PPML compared to traditional log-linear OLS estimates.

There is a practical advantage of choosing the Poisson pseudo maximum likelihood (PPML) estimator. Its implications for the functional form of the specification of the model imply that we do not drop zero trade flows .

Yingwu and Tingyu (2015) have used PPML in the estimation of gravity models and found that PPML is more suitable for nonlinear relationships in models and has desirable and robust properties even with the presence of different types of heteroscedasticity and measurement errors.

There may be heteroscedasticity in tea export trade data, and White's heteroskedasticity robust standard error can be selected to overcome the possible impact of heteroskedasticity on the results when estimating the log gravity model using the PPML method (Head & Mayer, 2013).

2.2.4 Monte Carlo evaluation of estimators of gravity models

After describing the different theoretical settings, Head and Meyer (2013) use Monte Carlo analysis to evaluate which specifications or methods that conform to theoretical predictions appear to be reliable and to restore the real parameter values.

Martin et al. (2015) reconfirm the assessment of Santos Silva and Tenreyro (2006) that the PPML estimator has more ideal results than other estimators,and the coefficient estimates are much less subject to bias results from heteroskedasticity with monte carlo simulations.

Disdier and Head (2008) find that if a gold medal error is made that did not control the MR terms, the distance coefficient is biased.

Additionally, Monte Carlo's results indicate that instead of choosing PPML as the single "workhorse" estimator of the gravity equation, it is better to use it as part of a robust exploration that also includes OLS and Gamma PML (Head & Mayer, 2013).

2.3 Recent literature on gravity models

2.3.1 The application of gravity model on Agriculture trade

Gravity model applications have been widely used to model agricultural trade and to study the empirical impact of food safety standards on trade.

Otsuki et al. (2001) use a gravity model to estimate the impact of EU aflatoxin standards on food imports from Africa. They show that, after controlling for the real per capita GNP in European and African countries, average rainfall in African countries, distance between the EU and African countries, time trends, and colonial ties (represented by a dummy), a 10% tighter aflatoxin standard in European countries can reduce edible groundnut imports by 11%.

Wilson and Otsuki (2004) useda similar gravity model to analyze the impact of MRLs on the pesticide chlorpyrifos for the banana trade. The effect of MRLs on the pesticide chlorpyrifos in the banana trade is analyzed using a similar gravity model by Yue (2004). Their results suggest that with a 1% increase in regulatory stringency, the banana trade decreases by 1.63%. Similar methods are used to study the impacts of non-tariff barriers by Moenius (2000), Wilson, Otsuki, and Majumdsar (2003), and Chen et al. (2008).

2.3.2 Recent Literature on gravity models regarding Chinese trade

Some Chinese scholars also pay attention to the factors affecting trade volume based on the gravity model.For example, Shi & Gu (2005) systematically combine empirical research with the gravity model, and apply the trade gravity model to China's international trade. Additionally, Gu (2001) notes that the influence of the transition economy on China's trade volume and trade direction must be taken into account when forming China's trade gravity model. Further, Luo (2003) discusses the distance factors in the gravity models, and Sheng & Liao (2004) use the gravity model to examine the key factors of export volume in emerging markets.

Schnatz et al. (2006) used a gravity model-based benchmark to assess China's degree of integration in world trade based on the size of their economy, location, and other relevant factors[6]. Irshad, Qi, Zhang & Arshad (2018) use a gravity model approach to analyze Pakistan's bilateral trade and potential trade with China.

Their results show that the GDP, WTO, trade openness, and common borders of the two countries have a positive impact on bilateral trade between Pakistan and China.

Previous studies have provided a good basis for the analysis of this study. However, there is still a lack of data on empirical analysis concerning the impact of food safety standards on international green tea trade.

2.4 What are non-tariff measures?

Different literature has different definitions of non-tariff measures (NTMs). According to the definition proposed by UNCTAD (2012), NTMs are policy measures, other than ordinary customs tariffs, that can potentially have an economic effect on international trade in goods. They can change quantities traded, prices, or both.

The International Classification of NTMs (2019) follows the classification criteria for all measures relevant to today's international trade. It includes various types of quantitative constraints, including quotas imposed for non-economic (i.e. religious, political, moral, and cultural) reasons. Moreover, it includes technical measures, such as sanitary or environmental protection measures.

Technical barriers are short for technical trade barriers. Technical barriers to trade are one of the most important factors affecting the development of bilateral trade. They refer to the technical measures taken by a country to maintain national security, protect human health and safety, protect the ecological environment, prevent fraud and ensure product quality.

[6]https://www.researchgate.net/publication/23961547_Evaluating_China's_Integration_in_World_Trade_with_a_Gravity_Model_Based_Benchmark

As the main technical trade barrier, the maximum pesticide residue limit standard has a severe impact on the foreign trade of China's agricultural products, especially the tea trade which is one of its traditional products.The more pesticides are regulated, the stricter the safety standards for tea. Developed countries have formulated very stringent MRL standards for tea imports on the grounds of protecting human health and safety. For example, in 2006, Japan began to implement the "Positive List System," in which there are as many as 251 pesticide residue limits related to tea.

The types of non-tariff measures related to tea are listed and discussed in more detail in the data section on pesticide standards.

2.5 Literature on Non-Tariff Measures affecting the China's Tea Exports

Under the trend of an increasingly globalized economy, the trade exchanges between different countries has become the main channel for economic globalization. In the export and import trade of each country, green trade barriers are far more important than other trade barriers (Wang et al., 2018)[7]

The empirical literature shows how different types of NTMs lead to different empirical effects. Multiple studies have shown that NTMs hinders trade. (e.g. Wei et al. 2012). This paper summarizes previous research about the impact of non-tariff measures on Chinese tea trade, focusing on two main aspects:1) Pesticide Standards; and 2) Other types of quantitative constraints, which include quotas imposed for non-economic reasons.

2.5.1 Literature on the effects of pesticide standards on Chinese agriculture trade

Wei et al.(2012) investigate how the tea safety standards indicated by the Sanitary and Phytosanitary (SPS) measures and the maximum residue limits (MRL) of pesticides in major importing countries affect China's tea exports.

[7] Green barriers are also called environment barriers, and green protectionism. Because the importers of products want to protect their own limited resources (human, animal, and plant health and the ecological environment) in modern international trade, through the formulation and implementation, they issue strict environmental protection laws and regulations to achieve environment protection and technology standards. The green barriers prevent foreign products from entering the domestic markets.

They use the gravity model with fixed effects which accounted for the MRTs. Their main conclusions show that the MRL of pesticide can significantly hinder China′s tea exports.

Dong and Zhu (2015) propose a different method to analyze tea exports from the perspective of the SPS gap between China and importing countries. They use panel data on China and its 10 developed country trading partners from 1992 to 2013. They use a gravity model to quantify the qualitative and quantitative impact of the SPS gap between China and its partners on China's tea exports. The results show that the difference of SPS measures in quality and quantity is the main determinant restricting the quantity of Chinese tea exported to developed countries.

Wang et al. (2018) also use a gravity model in the analysis of the trade status of Chinese tea in the EU market to empirically analyze the impact of residue regulations on Chinese tea exported to the EU. They collect EU orders from previous years to obtain the EU's provisions on pesticide residues in imported tea.The results show that when the EU recently issued the pesticide residue limit index, it had a significant impact on the world's major tea exporters, as shown by the decline in exports.

The other two studies, Guo-da Niu Xiao-jing and Zhang (2007) and Wang et al. (2018), focus on the trade that goes via Japan to the EU.

Guo-da Niu Xiao-jing and Zhang (2007) take the Sino-Japanese tea trade as an example, and briefly introduce Japan's trade technical barrier and China's standards system of MRL pesticide. It then quantitatively analyzes the important role of tea products in Sino-Japanese trade and uses gravity models to do an empirical analysis on how the technical barriers to trade affect Sino-Japanese tea trade. In their paper, the authors determine the major events that caused Japan to create the limits of pesticide residues more stricter in imported tea in recent years. In the gravity equation, the promulgation of the three laws of "National Standards for Tea Hygiene" in 1988, "Green Food-Black Tea and Green Tea" in 1995, and "Non-Pollution Food-Tea" in 2001 were used as the basis for the value of dummy variables.

The results imply that if Japan enacts new pesticide residue regulations, meaning the technical trade barriers are strengthened, the results will have a significant negative effect on tea trade between China and Japan. According to the results, the policy implications are obvious. For the continuous increase of China's tea trade, it would be better for China, and especially for the tea enterprises, to pay close attention to Japanese standards and adjust the production in accordance with Japan's limited requirements (Guo-da Niu Xiao-jing & Zhang, 2007).

2.5.2 Gravity model & Tea Trade results

Table 1

Reference	**Focus**	**Observations**	**Data resources**	**Period**	**Data on the MRLs of pesticides and the coverage of regulated pesticides**	**Estimation methods**	**Preferred Estimator**	**Results**
Wei,Guoxue &Huang, Jikun&Yang ,Jun （2012）	impacts of food safety	31 countries	COMTRADE/UNCTAD	1996 - 2009	various literature and policy document reviews, particularly on information obtained from the UK Health and Safety Executive database, the Codex database on pesticides from the Food and Agricultural Organization of the United Nations (FAO), the Japan Food Chemical Research Foundation database, and other studies in Chinese (Chen, 2004, 2007)	OLS, country fixed -effects -dummy variable/time dummies	country fixed - effects	Robust
YinguoDong & YueZhu(2015)	SPS gap:Maximum Residual Limits of fenvalerate and endosulfan	panel data/10 developed trade partners	UNCTAD	1992 - 2013		OLS, country-specific fixed effect and **random effects (Best one)**	PPML	significant
BoWang, JuanQiu, XiaoshanTang(2018)	pesticide residue limit standard	EU market		1998-2014	collecting EU orders of previous years	normal distribution test of goodness of fit for residual errors of regression model		significant

Ning Yue,1 Hua Kuang,1 Lin Sun,2 Linhai Wu3* & Chuanlai Xu1	maximum residue levels	cross-sectional data/eight countries	UN Statistics Bureau COMTRADE	1997-2006		OLS/dummy variable/e logarithmic expression pattern of gravitational equations/no heteroskedasticity		significant

2.5.3 Literature on tea trade & culture

A theoretical perspective

Under the trend of globalization, Chinese traditional culture has attracted more and more attention around the world.

Hobson (2004) notes that in terms of the sophistication of its culture, Confucianism values elite management, Chinese society had been at the forefront of human achievement until the 18th century.Additionally, Western ideological systems attach great importance to Eastern and Chinese philosophy and culture [8](Wong, 2020).

Sigley (2015) claims how when any country enters the "golden age", the issue of "cultural identity" naturally becomes more and more important. Moreover, from the conclusion of his thesis, it can be seen that tea continues to play an important role in the process of constructing Chinese identity[9].

Sigley (2015) also illustrates that China is actually a cornucopia, rich in many items that foreign traders desired, including tea,which is one of China's greatest contributions to human civilization.

Sigley (2015) further goes on to describe an interesting relationship between Chinese tea and culture. In his paper, he claims that in the first Opium War, tea was also crucial to China's "opening up" to the modern world.Additionally, he notes an interesting link between tea and the decline of common urban water-borne diseases

---

[8] Comparative Philosophy: Chinese and Western First published Tue Jul 31, 2001; substantive revision Tue Aug 4, 2020

[9] Specifically, Sigley writes that" When any nation enters a 'golden age', whether it be the United States of the 1950s and 1960s or China in the post-1992 period, the question of 'cultural identity' naturally becomes increasingly important. As China is emerging as a major player on the economic and political world stage it is also asking the question as to what kind of'Chinese culture should be encouraged into the 21st Century. China is rapidly changing and the government and people look to cultural identity as a means of creating a stable and common set of meanings to help bind the people and nation through this transition.``

during the industrial revolution in European cities such as London and the spread of tea. Thus, the import of tea may have played an important role in improving urban health in Europe. Tea also provides a stimulating habitual drink for people around the world. Over time, it may develop a new set of practices that are relevant and suitable to modern daily life.

In addition, language and Chinese vocabulary also play an important role in the spread of traditional Chinese culture, represented by tea, throughout the world. Vocabulary is one basic carrier of culture[10]. Chinese vocabulary has continuously formed and evolved in the process of cultural development, and it has deep cultural connotations.

For example,the etymology of the word *tea* to be discussed in this paper can be traced can be traced back to the various Chinese pronunciations of the Chinese word 茶. The words used in "tea" in various languages reveal where tea and tea culture were first obtained in these countries.Almost all tea words in the world are divided into three categories: te, cha and chai.

The Dutch first introduced tea to England in 1644. By the 19th century, most English tea was purchased directly from merchants in Guangzhou, who used cha[11].The word "teapot" in Polish is czajnik, which can come directly from chai or the cognate Russian word (Victor H. Mair and Erling Hoh ,2009). Since about the beginning of the 20th century, Czech has used čaj to mean "tea"(Victor H. Mair and Erling Hoh ,2009).Tra and che are variants of tea"“茶”; The latter, used mainly in northern Vietnam, describes tea made from freshly picked leaves.

10 https://baike.baidu.com/item/%E4%B8%AD%E5%9B%BD%E4%BC%A0%E7%BB%9F%E6%96%87%E5%8C%96/6211

11 "Tea"-. Online Etymology Dictionary. Retrieved 29 June 2012.(https://www.etymonline.com/word/tea)

Therefore, as seen from the above examples, Chinese cultural e has a long history of being influential. This cultural influence could potentially enact a present-day desire to import and drink Chinese tea.

A practical perspective

Hang and Kai (2014-2015) adopt a trade gravity model to conduct an empirical study on the actual impact of cultural exchange on the export of Chinese Characteristic Agricultural Products (CAPs). Their research is based on 2004-2015 panel data of China and 43 countries, taking Chinese immigrants, overseas students, and tourists as the proxy variables in long-, medium- and short-term cultural exchange, and taking tea as a typical case of a Chinese Characteristic Agricultural Products.The results confirm a significantly positive relationship between China's tea exports and the increase of overseas students and tourists in China. More specifically, foreign students studying in China will deepen their understanding and experience of food culture with Chinese characteristics including the tea ceremony.

Additionally ,foreign tourists can_experience typical Chinese food systems including tea, which also helps convey Chinese and foreign food information and preferences. In both instances, the experiences of foreigners in China can stimulate demand for Chinese products and promote the export of agricultural products with traditional Chinese characteristics.

Based on the results, a suggestion is put forward to increase reliance on overseas student groups to carry out cultural exchange between China and foreign countries, so as to promote the export of Chinese tea.

Section 3

Descriptive part

3.1 Analysis on the total volume of world green tea exports and proportion

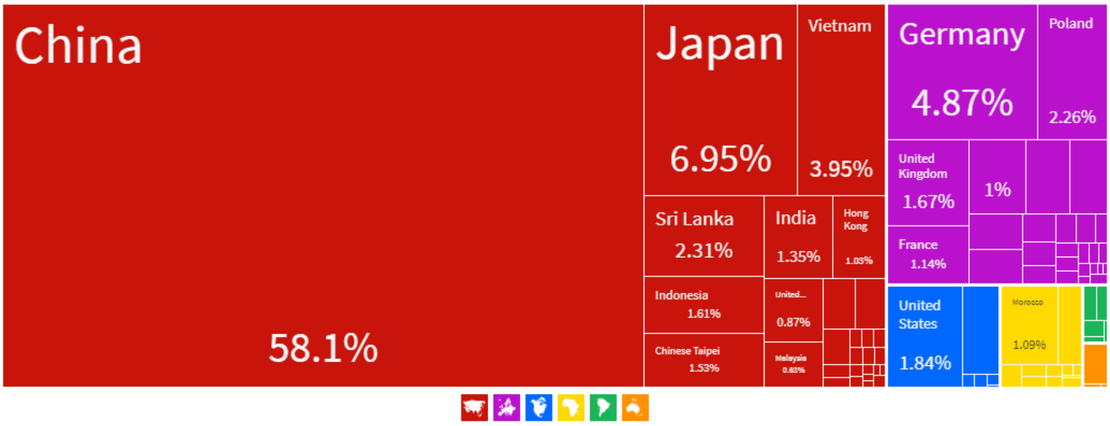

Figure 1：Total volume of world green tea exports and proportion 2018

Data source: OEC latest data (https://oec.world/en/visualize)

As seen in Figure 1, currently the world's green tea exporters are mainly clustered in developing countries in Asia and Europe. The top three exporters in Asia are China, Japan, and Vietnam, with tea export market shares of 58.1%, 6.95% and 3.95%, respectively. The biggest Asian exporter is China, with a trade value of up to $1.19B, thus ranking as the top tea exporter in the world. In Asia, Sri Lanka and India also have shares in the tea export market.

The top exporters in Europe include Germany and Poland. Their tea export market shares are 4.87% and 2.28%, respectively. However, they do not grow tea, but rather import it from other countries before exporting it again. For example, The main Polish tea suppliers are India, Indonesia, Sri Lanka, China and Vietnam. Poland is China's main tea export market. According to Chinese customs statistics(2018), China exports 878 tons of green tea to Poland[12].

Comparing 1995 to 2018, Japan replaced Hong Kong as the second largest green tea exporter in Asia, and Germany replaced France as Europe's largest exporter. Please see the Appendix for more detailed data.

3.2 Total volume of world green tea imports and proportion

[12] http://www.ccpit.org/Contents/Channel_4159/2020/1231/1318664/content_1318664.htm .https://www.qufair.com/news/2018/02/26/16140.shtml

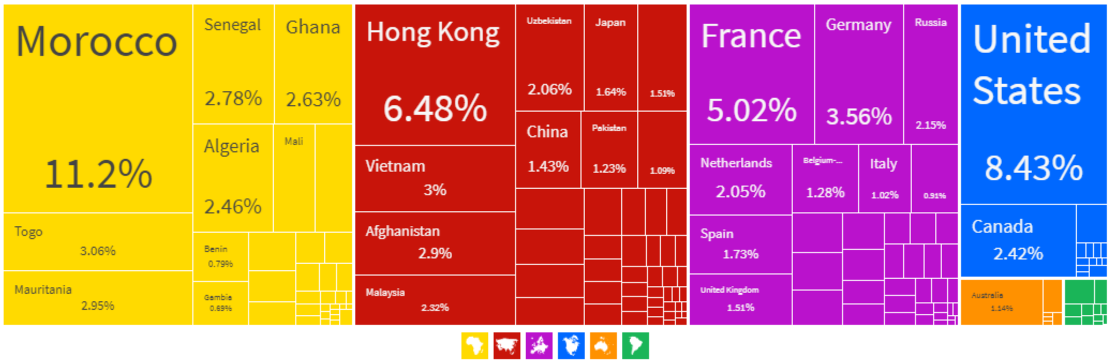

Figure 2：Total Volume of world green tea Imports and Proportion

Data source: OEC latest data (https://oec.world/en/visualize)

In 1995, Asian and European green tea imports ranked second and third respectively among the seven continents of the world. Among them, Japan and France rank second and fifth in the world.Their tea import market shares are 6.36%, and 5.02% respectively.

In 2015, the world's largest green tea importing continent was Africa,with trade value of up to $512M. Although North America ranks fourth in the world, the United States ranks second in imports in the world, and their tea import market share is 8.64%. More detailed data are in the appendix.

3.3 EU green tea imports in recent years

European green tea imports are increasing in value

Although the total volume of EU green tea imports and their share in the world have decreased in certain years since 1995, for example, between 2013 and 2015, from 1995 to 2016, EU green tea imports as a whole still had an upward trend (as shown in Figure 3 below).

In 2005, Europe's total imports ranked first among the seven continents of the world. The top four exporters were Morocco, the United States, Japan, and France. Their tea import market shares were 14.1%, 10.1% , 7.39% and 6.31% respectively.[13]

Even in 2006 and 2011, the total volume and proportion of EU green tea imports ranked first in the world, indicating that the EU market will be a potential market for green tea imports in the future.

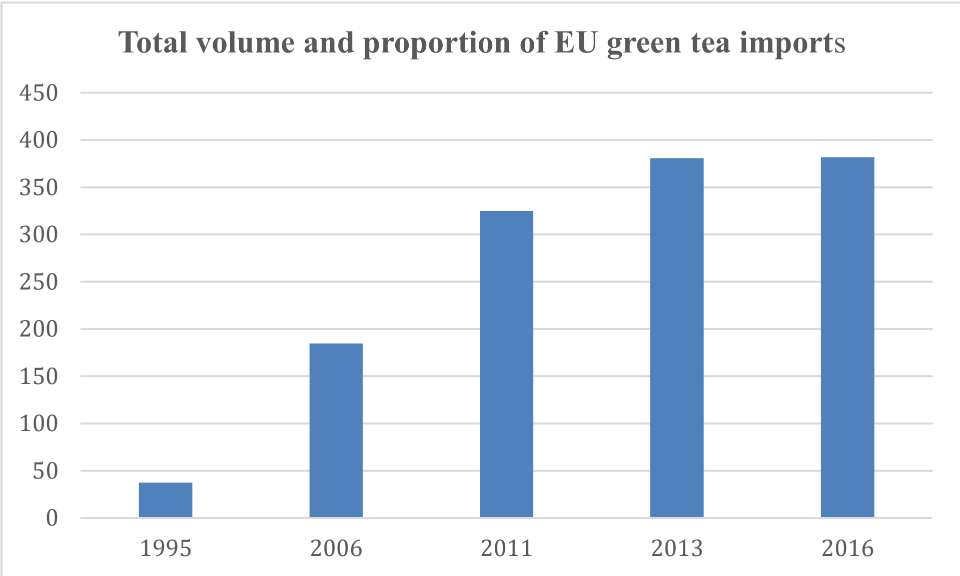

Figure 3: Total volume and proportion of EU green tea imports

Data source: OEC latest data (https://oec.world/en/visualize)

Interesting European markets

Figure 4 shows the largest importers of green tea in Europe. France and Germany are by far the two largest green tea importers in Europe. Russia is another leading importer.

[13] https://oec.world

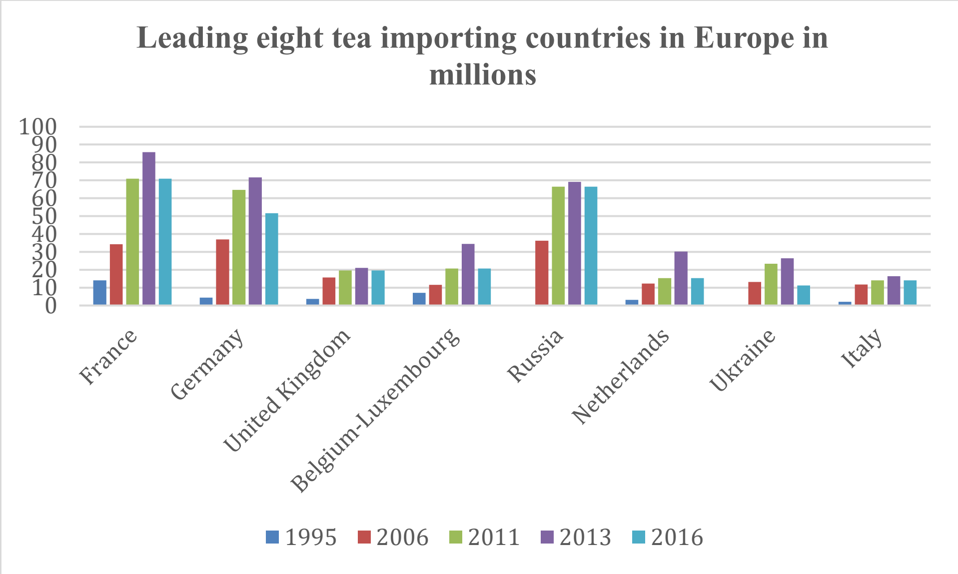

Figure 4. Data source:OEC latest data (https://oec.world/en/visualize)

As seen above there is a growth trend in the EU tea market, this is one reason why I chose the EU as a research object for green tea exports.

The second reason is that Europe does not have a suitable climate to grow tea, and almost tea is imported (mostly from developing countries Therefore, consumption of tea in the European Union depends on imports.

Another reason for pursuing Europe as a research object is that European consumers increasingly pursue a unique and authentic tea-drinking experience which cannot be found in the mainstream market.[14] Consumers are willing to spend more on the tea they consume, which leads to a shift to more expensive, high-quality (premium) products. This led to the high-end tea market. In addition, the health awareness of tea consumers has increased, and it is generally believed that green tea contributes to health. This is also boosting the demand for green tea.[15]

3.4 Review of China's tea exports

---

[14] https://www.cbi.eu/market-information/tea/trends

[15] https://www.cbi.eu/market-information/tea/trends

China has the richest tea resources in the world and was the first country to discover tea Sigley (2015).

At present, China is the world's largest exporter of green tea (2018), indicating that China is one of the world's major tea producers and exporters.Tea is one of the traditional commodities that China exports to the European Union, the United States and Japan.

Where does China export green tea? (2018)		
Country	Trade Value	Percent (%)
World	$2.16T	100
United States	$478B	22.20%
Japan	$146B	6.78%
South Korea	$109B	5.04%
Vietnam	$82.8B	3.84%
Germany	$77.3B	3.59%
India	$76.7B	3.56%
Netherlands	$73.2B	3.39%
UK	$56.4B	2.61%
Singapore	$48.6B	2.26%
Russia	$48B	2.23%

Table 2

Data source:OEC latest data (https://oec.world/en/visualize)

Although China has exported tea to more than 140 countries/regions, its importers are quite concentrated (as shown in Table 2).The top 28 markets are mostly located in Asia,North America and Europe, and their imports account for 71.82% of China's total tea exports. The United States, Japan, South Korea, Vietnam and Germany are the top five importing countries, accounting for 41.45% of China's total tea exports values in 2018. (Table 2).

The status of Chinese green tea exports from 2004-2007

As mentioned above, food safety standards affect tea exports. Therefore, the hope is that through the existing pesticide standards and the distribution of tea exports, I can test whether tea exports are affected by the pesticide standards.More specifically, I select years where the pesticide standards in the EU have recently changed significantly.

For example, The MRL for the EU on endosulfan dropped substantially, from 30 ppm between 1996 and 2004 to only 0.01 ppm in 2005 and 2006, before it reverted to its initial standard of 30 ppm in 2007. Thus I choose 2004 to 2007 as the years of analysis to observe the world's green tea exports.

World's major tea exporting countries (2004)			**World's major tea exporting countries (2005)**			**World's major tea exporting countries (2006)**			**World's major tea exporting countries (2007)**		
Country	Trade Value	Percent (%)	Country	Trade Value	Percent(%)	Country	Trade Value	Percent Percent(%)	Country	Trade Value	Percent Percent (%)
World	$558M	100	World	$558M	100	World	$703M	100	World	$812M	100
China	$319M	57.10%	China	$319M	57.10%	China	$378M	53.80%	China	$422M	52.00%
United Kingdom	$27.2M	4.88%	Germany	$36.4M	6.08%	Germany	$40.8M	5.81%	Germany	$51.7M	6.37%
Germany	$25.1M	4.50%	United Kingdom	$29.4M	4.92%	United Kingdom	$40.6M	5.78%	United Kingdom	$42.3M	5.21%
Sri Lanka	$21.9M	3.92%	Sri Lanka	$21.4M	3.57%	Sri Lanka	$30.1M	4.27%	Sri Lanka	$38.5M	4.74%

Papua New Guinea	$20.1M	3.60%	Vietnam	$21.3M	3.56%	Japan	$29M	4.13%	Japan	$36.3M	4.47%

Table 3, Data source:OEC latest data (https://oec.world/en/visualize)

It can be seen from Table 3 that China's green tea exports as a percentage of the total world exports are indeed decreasing in 2006 and 2007.

The decline in tea export growth has attracted a lot of attention in China. This raises the question of what factors might affect the different trends of China's tea exports to importing countries.

Some argue that based on the relative comparative advantages of other major tea exporting countries (such as Germany, the United Kingdom, Sri Lanka and Japan), the decline in the share of Chinese tea exports in the international market is due to the increase in tea production.(Xu,Y.2006)

Some people believe that lower[16] export prices than other competitors may be another possible reason for the decline in China's green tea exports. From 1997 to 2009, the unit price of Chinese tea is not only lower than the world average, but also lower than that of other major exporting countries.(see Figure 3). For example, China's export prices in 2009 were only 27% of Japan's.On the one hand, relatively low export prices may be the result of poor quality or prevailing competitive strategies. But on the other hand, this may indicate that Chinese tea is just an ordinary product, rather than an active participant in the high-end market.

[16] Lower prices would (ceteris paribus) higher demand for Chinese tea, but they might indeed make Chinese producers less interested in tea production and exports.

Figure 5, Data source:Database and Models - CEPII

More detailed information can be found in the appendix.

Others argue that changes in the safety standards imposed on China's tea exports are the main reason for the decline in China's tea exports, Gu and Niu (2007). They also believe that Japan's strict tea safety standards have seriously affected China's tea exports. Sun et al. (2007) claimed that the EU's changes to maximum residue limits (MRLs) since 2000 have increased the cost of Chinese tea production and reduced China's tea exports to the EU by approximately 1%.

In the next two sections, I descriptively and empirically examine tea safety standards, import non-tariff measures and other factors such as cultural effects that may have affected tea exports.

Section 4

Data and Methodology

4.1 Data

In the data section, I first briefly introduce general information about the original and the merged dataset.

This study uses BACI Data from the Centre d'Etudes Prospectives et d'Information Internationales (CEPII[17]). This data is based on Comtrade data, but includes two major adjustments. The first is that it reconciles duplicate reported data when both exporting and importing countries report to Comtrade, creating a single flow for trades; the second is that it evaluates the reliability of countries' reporting.

In addition to the export trade data, Table 4 below summarizes all other variables used in the regression of the basic gravity model.

Table 4

Variable	Description	Source
Exports(exports)	Unilateral export flows from 213 exporting countries to 224 partner countries (173,332 observations)	CEPII - BACI
GDP Exporter (gdp_ex)	Gross domestic product of the exporting country (current US$)	World Bank Group
GDP Partner (gdp_p)	Gross domestic product of the partner country (current US$)	World Bank Group
distance (dist)	Distance measures the distance between two countries applying the great circle formula.[18]	CEPII Geodist database
contiguity(contig)	Contiguity is a dummy variable which is equal to 1 if two countries share a common border and 0 otherwise.	CEPII Geodist database

[17] http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=37

[18] which takes into account the most important cities and their population size, i.,e.the shortest distances measured on the earth's surface irrespective of actual highways or sailing routes.

common language ethno (comlang_ethno)	Common language ethno is a dummy variable that takes the value 1 if in two countries at least 9% of the population speak the same language and 0 otherwise	CEPII Geodist database
colony (colony)	Colony is a dummy variable that takes the value 1 if there was any colonial relationship between two countries and 0 otherwise.	CEPII Geodist database
tea_etymology	tea_etymology is a dummy that takes the value 1 if the importer uses "cha" as the origin or derivative of the word "tea" and 0 otherwise.	World Atlas of language Structures.Wiktionary

With decreasing tariff rates on tea imports, non-tariff measures such as tea safety standards among importing countries may be the main obstacles to tea exports. However, one of the main challenges of this paper is to determine how to measure the impact of tea safety standards on the export of green tea.

An indicator of food safety standards often used in empirical research is the maximum residue level of pesticides (MRL).[19] More specifically, endosulfan, fenvalerate, and flucythrinate are the three types of pesticides once widely used in tea production.

The data on the maximum residue limits of pesticides are based on the review of various literature , policy documents and European commission standards.For more detailed information, please see Table 5.

[19] For food safety standards reflected by the MRL of pesticides often used in empirical studies.

The MRLs of endosulfan, fenvalerate, and flucythrinate in tea, 1996–2011.

Source: United Kingdom Health and Safety Executive Database, Codex Database on Pesticides of the Food and Agricultural Organization of United Nation (FAO),

Japan Food Chemical Research Foundation Database, and Chen (2004 and 2007)

*The above sources are directly quoted from this academic paper.[20]

Table 5

The endosulfan pesticide regulation of the EU from the European Commission[21](2008-2011)

Year	Importers	The MRLs of 3 major pesticides		
		endosulfan	fenvalerate	flucythrinate
	EU	30ppm->0.01ppm->30ppm	10ppm->0.05ppm	0.01ppm
	Japan	30ppm	1ppm	20ppm
	USA	24ppm	0.01ppm->0.1ppm	0.01ppm-0.1ppm
	Codex	30ppm		20ppm

*This is the overview of pesticides, with specific information found in the Appendix.

Another major challenge of this thesis is how to measure the impact of culture on Chinese green tea exports.

[20] Guoxue WEI a,b, Jikun HUANG a,⁎, Jun YANG ,The impacts of food safety standards on China's tea exports.

[21] https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=pesticide.residue.displayMRL&language=EN

Based on the information the literature on tea trade & culture section, this paper will use the tea etymology map to intuitively reflects the history of the spread of tea culture and trade from China to the rest of the world and use the “tea_etymology”as a dummy variable to consider the cultural effect between China and its green tea importing countries.

As can be seen from the figure below[22]:

The different words for tea are divided into two main groups: "te derivative" (Min) and "cha derivative" (Cantonese and Mandarin)[23]."The word for tea (cha) is'Sinitic', which means it is common among many Chinese," Sonnad wrote. "It originated in China and passed through Central Asia, eventually becoming 'chay' (چای) in Persian[24].

The later form, modern English tea, was translated through Dutch from Malay and directly from Chinese (Amoy dialect) t'e, which corresponds to Mandarin ch'a[25].

“The words that sound like ‘cha’ spread across land, along the Silk Road,” writes Quartz’s Nikhil Sonnad. “The ‘tea’-like phrasings spread over water, by Dutch traders bringing the novel leaves back to Europe.”

[22] https://qz.com/1176962/map-how-the-word-tea-spread-over-land-and-sea-to-conquer-the-world/

[23] "tea". Online Etymology Dictionary. The Portuguese word (attested from 1550s) came via Macao; and Rus. chai, Pers. cha, Gk. tsai, Arabic shay, and Turk. çay all came overland from the Mandarin form.

[24] https://www.etymonline.com/word/tea

[25] https://www.etymonline.com/word/tea

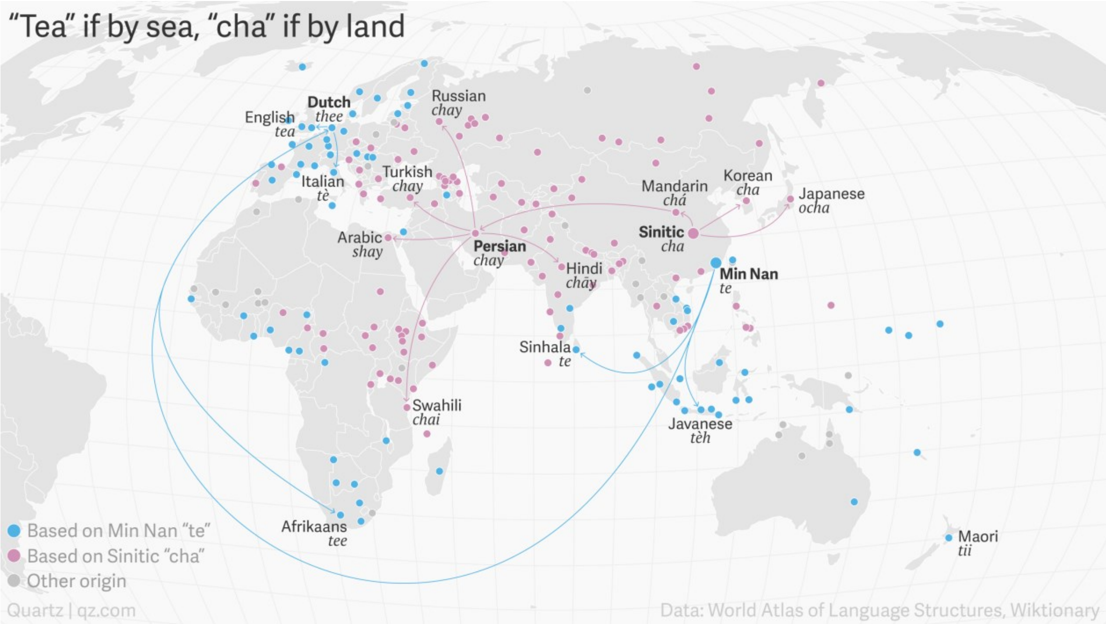

Figure 6:Tea-etymology map

Data source:World Altas of Language Structure.

4.1.1 Original data descriptive statistics and testing

In total, I include 173,332 observations (tea_data_1995_2018).

I perform data descriptive statistics and testing based on the merged data which includes 52,885 observations (trade_1992-2017_basic_gravity). Please see the table 6 below.

Summary of variables and Correlation between variables

Summary of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
export	47,387	470.8175	4031.671	1	225093.4

GDP_o	50,265	1.88e+12	3.95e+12	1.10e+07	8.64e+13
GDP_d	48,320	1.19e+12	3.51e+12	1.10e+07	8.64e+13
distw	47,387	5782.964	4405.316	60.77057	19516.56
tdiff	47,387	3.623035	3.310655	0	12

Table 6 reports descriptive statistics for the significant variables of the models including observations, mean, standard deviation, minimum and maximum.

Firstly, as seen from the summary of variables, there is a relatively sufficient number and similar structures of data observations. Generally speaking, the coefficients are more tightly estimated with many observations.

Secondly, a common problem of gravity models is one that has been criticized in the literature, namely the zero trade flow problem. If there are zero trade observations, then when the log of a log is taken, the log of zero is undefined. Thus, these observations will automatically be omitted.

As suggested by the literature on microfoundations of gravity, there may be a risk of selection bias. Furthermore, if zero observations account for a larger share of the total observations, the results of the gravity model may be unreliable.The model loses important information, and this information is reflected in the data when there is zero trade flow.

As shown in the above table , the minimum value of export is 1, showing that there are not any countries which contain zero trade in the sample. However, a situation may occur where someone collects data and sees the zero trade value, and then automatically removes that data. As mentioned above, in this case, the gravity model may have unreliable results. Therefore, whether the model has this problem will be explored later in this study.

The correlation between variables

Before the regression analysis,the correlation between the main variables of the model needs to be understood to examine whether there is a system multicollinearity problem in the model. There are two reasons why I add the tdiff to the correlation analysis. The first is that I try to collect as complete information in the beginning as possible in order to have a more reliable estimation result. The second is that I can test whether tdiff is indeed closely related to distance or whether it might include some additional information.

export	GDP_o	GDP_d	distw	contig	comlan~f	comcol	
export	1.0000						
GDP_o	0.1261 0.0000	1.0000					
GDP_d	0.0436 0.0000	-0.0771 0.0000	1.0000				
distw	0.0346 0.0000	0.1928 0.0000	0.1648 0.0000	1.0000			
contig	0.0290 0.0000	-0.0802 0.0000	-0.0336 0.0000	-0.3483 0.0000	1.0000		

comlang_off	-0.0258 0.0000	-0.0360 0.0000	-0.0168 0.0000	-0.0783 0.0000	0.1391 0.0000	1.0000	
comcol	-0.0282 0.0000	-0.1419 0.0000	-0.1037 0.0000	-0.1377 0.0000	0.1136 0.0000	0.2172 0.0000	1.0000
tdiff	0.0443 0.0000	0.2596 0.0000	0.2265 0.0000	0.8866 0.0000	-0.2866 0.0000	-0.1237 0.0000	-0.1303 0.0000
	tdiff						
tdiff	1.0000						

Table 7

The result contains two important information: (1) correlation coefficient; (2) statistical significance level.

The correlation coefficient matrix of model variables is listed in Table xx. According to this result, the correlation coefficient between **distw** and **tdiff** variables is 0.88, and thus it seems that the model has a system multicollinearity problem .

As the results from Table 7 show the correlation coefficient between distw and tdiff variables is 0.88, so when the tdiff variable is kept, the estimated coefficients for distw are significantly influenced by the effects of multicollinearity.

However, it is demonstrated that the VIF of both results are a little more than 1 and much less than 10, so there is no need to worry about the risk of multicollinearity.More detailed information about the results of VIF will be shown in the appendix.

The next question centers on deciding whether to remove or keep the **tdiff** variable. There are two main aspects that can be referred to.

Firstly, on the one hand, the **distw** is a more traditional variable in the gravity model. More specifically,for a commodity like team the distance can be a better approximation of transportation costs than the time-difference.

On the other hand, these two variables have a relatively close relationship. The correlation coefficient between **distw** and **tdiff** variables is 0.88, so if I have a **distw** variable in my model, then not including **tdiff** is not a problem.

Secondly, the **distw** and **tdiff** variables are time-invariant in my data, so in fact when I use an i-pair variable to run regression , the coefficients of these two variables will become zero. Therefore, it will not affect the results of the model regression.

4. 2 Methodology

In order to have a more complete and broader analysis of tea exports, I elaborate from three main perspectives to analyze the extent to which changes in specific regulations have affected tea exports.

The three main perspectives are described as follows:

Perspective 1:To see how tea trade looks and the variables that affect the tea export in the whole world, I estimate the coefficients of the gravity model by using different estimators. I then compare the results, on the one hand to see if they match the literature review, and on the other hand to find the most appropriate estimator under the current data.

Perspective 2: The hypothesis here is that the technical barrier will have a significant negative impact on all tea exporters in the world.Non-tariff measures play the main role in impacting tea exports, and they are indicated by pesticide regulation.Since I will only estimate those importing countries which have imposed pesticide regulations on tea from 1996 to 2012, the data sample will be smaller than the sample used in the Perspective 1.More specifically, an increase in the number of countries that create pesticide regulation standards will cause a decrease in the number of countries in the sample. Thus, the number of importing countries will be reduced, and the time dimension will be shortened from (1995,2018) to (1996,2012).

Perspective 3: The first hypothesis here is that a particular regulation (i.e. pesticide residues) has a significant negative impact on the export of Chinese green tea;the second is that if the importer takes "cha" as the origin or derivative of the word "tea", it will benefit the export of Chinese green tea.

The importing countries and the time dimension are the same as Perspective 2, specifically focusing on China as the only importing country and estimating the specific effect of the MRL of pesticides between China's tea export and the importing countries which have imposed the pesticide regulation.

Perspective 1

To obtain a general idea of the tea trade and the variables that affect the tea export, I first do an analysis using all available observations for all exporter and importer countries.The reason why I do not include the variable of non-tariff measures is because if I add non-tariff measures to the data, it means that countries that use non-tariff measures such as pesticide standards will be filtered out of my existing data. The key here is to examine whether the tea trade is consistent with the general gravity model and to determine which of the variables are important for tea exports in this data range.

From the result of the summary of original trade data, there are 173,332 observations about importers and exporters for the period from 1995 to 2018. There are 224 importing countries , and 213 exporting countries. In this sample, this amounts to bilateral trade relationships with almost 52,855 observations in the basic gravity regression after merging with other variables such as gdp, distance, comborder and so on (Table 8).

Dataset	Total number of observations	Number of exporters	Number of importers
Original trade data(exporter,importer,exports)	173,332	214	224
Merged data	52,855	186	208

The main determinants of the gravity model (that is, GDP per capita, geographic distance) and other related explanatory variables (contig, comlang_off, comcol) are introduced as control variables. The model (1) is constructed as follows:

$$LnX_{ij} = \beta_0 + \beta_1 LnY_{it} + \beta_2 LnY_{jt} + \beta_3 Lndi_{jt} + \beta_4 Lncontig + \beta_5 Lncomlang + \beta_6 Lncomcol ... + \xi_{it}$$

When predicting tea bilateral trade flows, the β terms are coefficients to be estimated, and εit is the error term, which is assumed to be normally distributed with a mean of zero.

Table X below shows the number of observations of different variables after taking the logarithm.

Dataset	**Total Number of observations**	**Number of exporters**	**Number of importers**
After taking Log & Panel data	47,387	185	207

Estimation methods

Model (1) is estimated using the following 3 methods: Panels - fixed effects, Panels - random effects, and Poisson Pseudo Maximum Likelihood(PPML) hdfe (Table 9)

	Fixed effects	Random Effects	PPML hdfe
Specifications	pair effects with time dummies	pair effects with time dummies	pair effects and time dummies (estimated via PPML hdfe)

Panels - fixed and random effects

There are two main reasons why I use fixed effects. The first is that in most of the current literature, the use of fixed effects to estimate gravity equations does not require strong structural assumptions about the basic model (Head & Mayer, 2013).

The second reason is that country fixed effect estimation controls for all unobserved non-time varying effects, including distance and other factors (e.g., contiguity

,colony and common language ethno) that are not considered in my model. A gravity model with fixed effects is more likely to avoid problems of inconsistency (Anderson & van Wincoop, 2003), which I mention in my literature review section.

More specifically, it is possible to avoid inconsistencies caused by missing variables by including competition from other tea exporting countries that may affect tea exports and global tea market conditions in different years and introducing time dummies (with bronze medal error) into the gravity model.

PPML

Santos Silva and & Tenreyro (2006) find that using the OLS method to determine the log gravity model leads to inconsistent results, while using the PPML method would overcome the problem of inconsistency. There may be heteroscedasticity in tea export trade data, and White's heteroskedasticity robust standard error can be selected to overcome the possible impact of heteroscedasticity on the results when estimating the log gravity model using the PPML method.

Zhang Yingwu and Zhu Tingyu (2015) use PPML in the estimation of a gravity model and find that PPML is more suitable for nonlinear relationships in the model. AFurther, they have desirable and robust properties even with the presence of different types of heteroscedasticity and measurement errors.

When I use the PPML method to do regression analysis on model 1, the variable of the export value will not take the form of log.

Estimated results

The observations and regression results of tea export value without non-tariff in 1995–2018 from the Panels - fixed effects, Panels - random effects and PPML hdfe are presented in Table 10

Table 10				
Variables	Fixed effects	Fixed effects(clustered errors/robust errors)	Random effects	PPMLhdfe
Observations	46,341	46,341	46,341	44,781
Number of exporters	185	185	185	185
Number of importers	207	207	207	207
With dummies	Pairs & Time			
lnGDP_o	.1553*** (0.0234)	.1553*** (0.0485)	.2148*** (0.0092)	-.0804 (0.098)
lnGDP_d	.1699*** (0.0259)	.1699*** (0 .0590)	.1842*** (0.080)	.4758 (0.190)
lndistw	0	0	-.1721 ***(0.0217)	0
contig	0	0	1.055*** (0.0815)	0

comlang_off	0	0	.2349*** (0.0485)	0
comcol	0	0	.3664*** (0.0680)	0
_cons	-6.058*** (0.8317)	-6.058*** (1.8961)	-7.2453*** (0.3515	-1.286 (4.214)
R^2	within=0.1524	within=0.1524	within=0.1521	
*** p<0.01, ** p<0.05, * p<0.1				

It can be seen from the results that the sign of the estimated *GDP* coefficient (usually the statistical significance level) is statically significant when using alternative econometric methods(fixed effect or random effect, columns 1–3 in Table 10). For example,the fixed effect model regression shows the expected sign for GDPs. Both are statistically significant at the 1% level.

In the random effect estimation method, the coefficients of *distance* and other variables are also expected to have negative signs. (rows 8-11, Table10)

However, when comparing the applicability of the fixed effect model and the random effect model, the Hausman test results show that the P value is equal to 0, and thus I reject the null hypothesis.Therefore, the panel fixed effects model is more appropriate to adopt. This appears to be a typical outcome for gravity models.

Column 4 of Table 10 reports the results from the PPML hdfe estimation and shows unexpected signs for one of GDP_o. Both are statistically insignificant at the 1% level.

Perspective 2

With decreasing tariff rates on tea exports, non-tariff measures such as tea safety standards reflected by the MRL of pesticides may be the main obstacles to tea exports. The rising and frequent changes of safety standards will bring more risks and additional costs to tea export.

The key question is as follows: How do changes in food safety standards affect tea exports?

The data of Model (2) is essentially the same as that of Model (1).The difference between these two models is that I include a total of 14 countries that have imposed MRL pesticide standards in Model (2). There are 12 EU countries: France, Belgium, Italy, the Netherlands, Luxembourg, Germany, the UK, Ireland, Denmark, Greece, Spain, Portugal, 1 in North America (the US), and 1 in Asia (Japan).

In this sample, this amounts to bilateral trade relationships with 9,282 observations in the basic gravity regression after merging with importing countries that implement pesticide standards (Table 11).

Total number of observations	**Number of exporters**	**Number of importers**
52,855	186	208
52,856	186	208
9,282	186	208

I then extend the basic Model (1) with non-tariff measures. Non-tariff measures are indicated by the MRLs for endosulfan, fenvalerate, and flucythrinate of the importing countries. GDP per capita, geographic distance, and other related explanatory variables (contig, comlang_off, comcol) are introduced as control variables.

The gravity model (2) used is specified as follows:

$$LnX_{ij} = \beta_0 + \beta 1 LnY_{it} + \beta_2 LnY_{jt} + \beta_3 Lndi_{jt} + \beta_4 Lncontig + \beta_5 Lncomlang + \beta_6 Lncomcol + \beta_7 Lnendo + \beta_8 Lnlendo + \beta_9 Lnflucy + \xi_{it}$$

where *endo*, *fen* and *flucy* denote the MRL of endosulfan, fenvalerate and flucythrinate, respectively on tea imposed by the importing countries.

Estimation methods

Model (2) is estimated by the same 3 methods as Model (1).[26]

Estimated results

Regression results of tea export value with non-tariff measures in 1995–2018 from the Panels - fixed effects,Panels-random effects and PPML hdfe are presented in Table 12.

Table 12			
Variables	**Fixed Effects (clustered)**	**Random Effects**	**PPMLhdfe**

[26]Panels - fixed effects, Panels - random effects, and PPML hdfe

Observations	4,840	4,840	4,650
Number of exporters	185	185	185
Number of importers	207	207	207
With dummies	Pairs & Time		
lnGDP_o	-0.056 (0.176)	0.341*** (0.0029)	-0.598*** (0.224)
lnGDP_d	-0.877*** (0.319)	0.391*** (0.046)	1.35*** (0.478)
lndistw	0	0.131** (0.062)	0
lnendo	0.031** (0.012)	0.022** (0.013)	0.037*** (0.008)
lnfen	-0.069** (0.028)	0.065*** (0.019)	0.023 (0.032)
lnflucy	0	0.067 (0.045)	0
contig	0	0	0
comlang_off	0	0	0
comcol	0	0	0

cons	-20.2* (10.4)	-16.3*** (1.65)	-14.2 (14.0)
R^2	within = 0.1795	within = 0.1750	
***p<0.01, **p<0.05, *p<0.1			

The results of the fixed effect model show the expected sign of *GDP_d,*although an unexpected sign appeared to the coefficient of GDP_o in the fixed effects model. Since the overall GDP simply may not be quite related to the size of domestic output of the tea sector. It is a very imperfect proxy for it ,therefore the outcome is not so troubling.

The coefficients for *distance and other variables* were also expected to have negative signs in the random effects estimation method (rows 8-11 , Table 12).

Comparing the applicability of the fixed-effect model and the random effect model, the Hausman test results show that the panel fixed effects model is more appropriate to adopt. This seems to be a typical outcome for gravity models as the result in the above Perspective 1.

The expected sign and statistical significance of *fenvalerate* support the hypothesis that non-tariff measures are important factors affecting tea export. That is, increasing the amount of MRLs often has a significant negative impact on tea exports.

An unexpected sign was observed for *endosulfan*. There may be two reasons for this:One is that the standards for *fenvalerate* are higher than those for *endosulfan.* The other one is that the EU has strengthened the supervision of imported tea; this includes a focus on strengthening the detection of pesticide residues. The key items tested are fenvalerate and other pesticide residues, and the sampling rate is as high as 10%.[27]

Because no variation is detected in any of the countries studied, Flucythrinate is removed from the regression analysis.(Table 12).

Column 4 reports the results from the PPML hdfe estimation and shows unexpected signs for GDP_o. Even though the results show the expected sign for one of GDP_d, it is statistically insignificant at the 1% level.

Perspective 3

As mentioned above (see Literature Review section), although the EU and Japan are countries with a large tea consumption,the export volume of Chinese tea is very small. It appears that one main possible obstacle to Chinese tea export is the non-tariff measure, such as the tea safety standards reflected by the MRL of pesticides.

The key questions are as follows: to what extent does the MRL of pesticides affect China's green tea exports? How does the cultural variable *(tea_etymology)* affect China's tea exports?

The data of Model (3) is essentially the same as that of Model (2). The difference between these two models is that I only choose China as an exporting country for Model (3).

[27] Resource:People's Republic of China Ministry of Commerce

I extend the basic Model (1) with non-tariff measures. In addition to non-tariff measures, including pesticide standards which are indicated by the MRLs for endosulfan, fenvalerate, and flucythrinate of the importing countries, the impact of cultural variables on China's green tea exports is also being introduced and discussed here. GDP per capita, geographic distance, and other related explanatory variables (contig,comlang_off, comcol) are introduced as control variables.

The gravity model used in this study is specified as follows when predicting tea bilateral trade flows:

$$\mathrm{Ln}Xij = \beta 0 + \beta 1 \ \mathrm{Ln}Yit + \beta 2 \ \mathrm{ln}Yjt + \beta 3 \ \mathrm{ln}dijt + \beta 4 \ \mathrm{ln}contig + \beta 5 \mathrm{ln}comlang\_ + \beta 6 \ \mathrm{ln}comcoll + \beta 7 \mathrm{ln}endo + \beta 8 \mathrm{ln}fen + \beta 9 \mathrm{ln}flucy + \beta 9 \mathrm{ln}tea\ \ etymology .. + \varepsilon it \quad ..\text{Model (3)}$$

where *tea_etymology* is a dummy that takes the value 1 if the importer takes "cha" as the origin or derivative of the word "tea" and 0 otherwise.

Estimation methods

Model (3) uses the same estimation methods as Models (1) and (2).

Estimated results

Regression results of tea export value with non-tariff measures and tea_etymology in 1995–2018 from the Panels - fixed effects, Panels - random effects and PPML hdfe are presented in Table13.

Table13 -A

Fe & vce(Pairs & Time)

	Pesticide regulation	tea_etymology	Pesticide regulation+tea_etymology
Observations	178	2915	178
Group variable: pair Number of groups	13	167	13
lnGDP_o	.456 (.279)	.681*** (.092)	.456 (.279)
lnGDP_d	1.41 (.913)	.335* (.184)	1.41 (.913)
lndistw	0	0	0
contig			
comlang_off			
comcol			
lnendo	.059 (.028)		.059 (.028)
lnfen	.019 (.035)		.019 (.035)
lnflucy	0		0
tea_etymology			0
_cons	--45.2 (18.6)	-22.5 (3.06)	--45.2 (18.6)

R^2	within= 0.4483	within=0.4402	within= 0.4483
*** p<0.01, ** p<0.05, * p<0.1			

Table 13-B

RE & (Pairs & Time)			
	Pesticide regulation	tea_etymology	Pesticide regulation+tea_etymology
Observations	178	2915	178
Group variable: pair Number of groups	13	167	13
lnGDP_o	.440 (.216)	. 601*** (.051)	.417 (.221)
lnGDP_d	1.48 (.290)	.501* (.054)	1.56 (.336)
lndistw	-5.33 (6.29)	-.682 (.319)	-4.25 (6.70)
contig			
comlang_off			
comcol			

lnendo	.059 (.046)		.061 (.046)
lnfen	.021 (.059)		.022 (.060)
lnflucy	-1.33 (1.80)		.671 (4.58)
tea_etymology		.693 (.588)	-9.32 (19.6)
_cons	-1.53 (52.8)	- 18.8 (3.28)	-8.14 (54.7)
R^2	within= 0.4482	within= 0.4391	within= 0.4479
*** p<0.01, ** p<0.05, * p<0.1			

Table 13-C

PPML hdfe & (Pairs & Time)			
	Pesticide regulation	tea_etymology	Pesticide regulation+tea_etymology
Observations	178	2911	178
Group variable: pair Number of groups	12	162	12

lnGDP_o	0	0	0
lnGDP_d	1.51 (.702)	.696* (.266)	1.52 (.702)
lndistw	0	0	0
contig			
comlang_off			
comcol			
lnendo	.052 (.010)		.052 (.010)
lnfen	.071 (.033)		.071 (.033)
lnflucy	0		0
tea_etymology		0	0
_cons	-34.4 (20.3)	- 7.67 (6.79)	-34.4 (20.3)
R^2			
*** p<0.01, ** p<0.05, * p<0.1			

The results show that the estimated coefficient for *GDP_d* is positive in all columns. Moreover,when I only estimate the impact of the *tea_etymology* variable on the tea trade, the *GDP_d* estimates in all estimated methods are significant (with at least a 10% level of statistical significance). From Table 13 it can be seen that although it is not statistically significant when I do regression analysis on pesticide standards only, or pesticide standards and etymology together. (2 cloumn and 4 column, Table 13), the GDP may not be quite related to the amount of tea imports. So it can be assumed that this is a very imperfect proxy variable, the result is not so troubling.

Distw variables show expected signs in all estimation methods. More specifically, they were expected to have negative signs in the random effects (Table 13). Although they are insignificant, they are negative.

When I only estimate the impact of pesticide regulation (e.g., endosulfan, fenvalerate, and flucythrinate) on the tea trade, the expected sign of *flucythrinate* in random effects (2 column,Table13-B) supports the hypothesis that non-tariff measures are important factors affecting tea export.Moreover, it shows the expected negative sign of flucythrinate.Although it is insignificant, it is at least negative.

An unexpected sign was observed for *endosulfan* and *fenvalerate*. There may be several reasons for this: One is that these two standards have fluctuated too much in some years (e.g. endosulfan reduced dramatically from 30.to 0.01ppm from 2004 to 2006 and fenvalerate reduced dramatically from 10 to 0.05 ppm from 1998 to 1999), and it is thus difficult to grasp their impact on tea exports. The second reason may be that the data of pesticide standards of the importing countries I selected are relatively limited and the information sources are not accurate enough, thus affecting its estimation.[28] The final possible reason may be due to technical issues, leading to the eventual results being contrary to the assumptions.

Column 2 (Table1-3 C) reports the result from the random estimation and shows expected signs for *tea_etymology*. Even though the result is not statistically insignificant, it at least shows the expected positive sign.

[28] It may be related to the small sample size in this study, which did not meet expectations due to sample size.

Since the results obtained do not fully support the hypothesis, I will therefore use the basic estimation method pooled OLS to test the regression results.

The details are shown in Table 14 below.

Basic traditional gravity model (pooled OLS)			
	Pesticide regulation	tea_etymology	Pesticide regulation+tea_etymology
Observations	178	2915	178
lnGDP_o	.122 (.202)	.250*** (.050)	.018 (.198)
lnGDP_d	1.51*** (.073)	.467*** (.022)	1.70*** (.104)
lndistw	-5.39*** (1.30)	-.381*** (.082)	-.4.08*** (.083)
lnendo	.011 (.038)		.024 (.038)
lnfen	-.004 (.079)		-.025 (.079)
lnflucy	-1.34 (.372)		. 1.47 (.835)
tea_etymology		.519*** (.136)	-.13.5*** (3.44)

_cons	7.53 (13.2)	-9.88*** (1.55)	-021 (13.0)
R^2	0.69	0.16	0.71
*** p<0.01, ** p<0.05, * p<0.1			

The results of the fixed effect model show the expected sign of *GDP_d.* For example,

The estimated coefficient for *GDP_d* is positive and highly significant (at the 1% level of statistical significance) in all columns.

The coefficients for *distance* also have the expected negative signs in all columns as well, and are statically significant at 1% level.

When I only estimate the impact of the pesticide regulation (e.g., endosulfan, fenvalerate, and flucythrinate) on the tea trade,the expected indications for *fenvalerate* and *flucythrinate* in column 1 support the hypothesis that non-tariff measures are an important factor affecting tea exports.An unexpected sign of *endosulfan* was observed.Please see possible reasons for these results on page 52.[29]

Additionally, when I only estimate the impact of the *tea_etymology* on tea trade,

the result shows the expected sign and is statistically significant in column 2, which supports the hypothesis that the cultural effect will positively influence China as it exports green tea..

Column 4 reports the result when I test the impact of pesticide regulation and cultural effect together, and the coefficient of *fenvalerate is* still expected to have negative sign.

[29] One is that the standards for fenvalerate are higher than those for endosulfan. The other one is that the EU has strengthened the supervision of imported tea; this includes a focus on strengthening the detection of pesticide residues. The key items tested are fenvalerate and other pesticide residues, and the sampling rate is as high as 10%.

However,the results show the unexpected sign of *tea_etymology*. The reason for the insignificant result may be that there is multicollinearity between geographical distance and tea source, by looking at the estimated value of distance.

Section 5

Estimation results

Summary of the results of the above three perspectives Table15

Perspective 1				Perspective 2		
Variables	Fixed effects(clustered errors/robust errors)	Random effects	PPMLhdfe	Fixed effects(clustered errors/robust errors)	Random effects	PPMLhdfe
Observations	46,341	46,341	44,781	4,840	4,840	4,650
Number of exporters	185	185	185	185	185	185
Number of importers	207	207	207	207	207	207
With dummies	Pairs & Time					
lnGDP_o	.1553*** (0.0485)	.2148*** (0.0092)	-.0804 (0.098)	-.056 (.176)	.341*** (.0029)	-.598*** (.224)
lnGDP_d	.1699*** (0 .0590)	.1842*** (0.080)	.4758 (0.190)	. .877*** (.319)	.391*** (.046)	1.35*** (.478)
lndistw	0	-.1721*** (0.0217)	0	0	-.131** (.062)	0
lnendo				.031** (.012)	.022** (.013)	.037*** (.008)

lnfen				-.069** (.028)	-.065*** (.019)	.023 (.032)
lnflucy				0	.067 (.045)	0
tea_etymology						
contig	0	1.055*** (0.0815)	0	0	0	0
comlang_off	0	.2349*** (0.0485)	0	0	0	0
comcol	0	.3664*** (0.0680)	0	0	0	0
_cons	-6.058*** (1.8961)	-7.2453*** (0.3515)	-1.286 (4.214)	-20.2* (10.4)	- 16.3*** (1.65)	- 14.2 (14.0)
R^2	within=0.1524	within=0.1521		within=0.1795	within= 0.1750	
*** p<0.01, ** p<0.05, * p<0.1						

Perspective 3:Fixed effects			**Random effects**			**PPMLhdfe**		
Pesticied reguation	tea_etymology	Pesticied reguation +tea_etymology	Pesticied reguation	tea_etymology	Pesticied reguation+tea_etymology	Pesticied reguation	tea_etymology	Pesticieder eguation+tea_etymology
178	2915	178	178	2915	178	178	2911	178
13	167	13	13	167	13	12	162	12

.456 (.279)	.681*** (.092)	.456 (.279)	.440 (.216)	.601*** (.051)	.417 (.221)	0	0	0
1.41 (.913)	.335* (.184)	1.41 (.913)	1.48 (.290)	.501* (.054)	1.56 (.336)	1.51 (.702)	.696* (.266)	1.52 (.702)
0	0	0	-5.33 (6.29)	-.682 (.319)	-4.25 (6.70)	0	0	0
.059 (.028)		.059 (.028)	.059 (.046)		.061 (.046)	.052 (.010)		.052 (.010)
.019 (.035)		.019 (.035)	.021 (.059)		.022 (.060)	.071 (.033)		.071 (.033)
0		0	-1.33 (1.80)		.671 (4.58)	0		0
		0		.693 (.588)	-9.32 (19.6)		0	0
-45.2 (18.6)	-22.5 (3.06)	-45.2 (18.6)	-1.53 (52.8)	- 18.8 (3.28)	-8.14 (54.7)	-34.4 (20.3)	- 7.67 (6.79)	-34.4 (20.3)
within= 0.4483	within=0. 4402	within= 0.4483	within= 0.4482	within = 0.4391	within= 0.4479			

The results of Perspective 1 show that the gravity model tracks international trade well, which is based on the size of the economy, distance, and other relevant factors.

One of the most important results from Perspective 2,the overall goal of this paper can be seen from measuring the coefficients of the variables regulated by pesticides regulation.

The estimated coefficient of *fenvalerate* confirms the hypothesis presented in the previous section (Hypothesis 1). When using alternative econometric approaches (fixed effect, random effects, and PPMLhdfe in Table 9), the result from the fixed effects and random effects show that the estimated coefficients have a negative sign, and both are statistically significant.That is, the stricter the pesticide standards are as represented by MRls such as fenvalerate of importing countries, the more China's green tea exports will decline.

From the regression result of Perspective 3, it can be seen that the estimated coefficient of *flucythrinate* supports the hypothesis presented in the previous section (Hypothesis 2). When using random effects , the results show that the estimated coefficient has negative sign. Although the degree of impact is not significant from the P value, it can be found from the coefficient that the pesticide standard has a negative relationship with the export scale of green tea.That is, increasing the non-tariff measures which are represented by MRls such as *flucythrinate* has a significant negative impact on tea exports. The reason behind the insignificance may be related to the small sample size in this study, which did not meet expectations.

The estimated coefficient of tea_etymology and Chinese tea export is 6.93. The results show that if the importer uses "cha" as the origin or derivative of the word "tea”, it will have a positive effect on China’s green tea exports.More specifically, when the importing country has language similarity with China, (for example: tea etymology), it will promote the export of Chinese green tea to these importing countries.

Section 6

Conclusions

The results indicate that the Maximum Residual Limit of pesticides have led to a decline in the growth rate of tea exports from a world perspective. In particular, the flucythrinate limits imposed by importing countries have significantly affected China's tea exports.

Based on the above analysis, this paper proposes the following suggestions for increasing the export of green tea:

China should adhere to the international standards. This can include referring to the Codex Alimentarius Commission standard and European Commission standards , modifying existing national standards, and perfecting the pesticide residue standard system for tea to make Chinese tea more competitive in the international market.he government and enterprises should increase investment in technology to improve pesticide residue inspection and control capabilities and ensure export standards.

From the government level, China should actively establish efficient technical measures, create management systems, and respond to technical regulations. Further, it should establish information centers and databases, use early warning mechanisms to further improve technology and market informatization, obtain foreign technical information standards, complete rural information systems as soon as possible, strengthen research and guide tea production, improve the technological innovation capabilities of the tea industry, and promote cleaner production for the benefit of the export of products.

This paper adopts the trade gravity model to take tea etymology (the origin of the word tea) as a proxy variable of cultural influence, and empirically studies the actual influence of cultural exchanges on the export of Chinese agricultural products. Empirical research shows that per capita income and studying in China have a significant complementary effect on China’s tea exports. This suggests that to extract the value of Sino-foreign cultural exchanges to promote the export trade of tea and other agricultural products with Chinese characteristics, the characteristics of Chinese food should be emphasized. This could include considering health preservation function and cultural connotation, paying attention to the cultural dissemination effect of overseas education in China by developed countries, and publicizing and promoting the health, green and natural life concepts contained in the Chinese characteristic diet to meet high-income country residents' pursuit of a quality, health and environmental protection life consumption concept.

Reference

Anderson, J. (1979): "A theoretical foundation for the gravity equation." The American Economic Review 69(1): pp. 106-116.

Anderson, J. & E. Van Wincoop. (2003): "Gravity with gravitas: A solution to the border puzzle." The American Economic Review 93(1): pp. 170-192.

Anderson, J. & E. Van Wincoop. (2004): "Trade costs." Journal of Economic Literature 42(3): pp. 691-751.

Baldwin, R. & D. Taglioni. (2006): "Gravity for dummies and dummies for gravity equations." National Bureau of Economic Research.

Baier, S. & J. Bergstrand. (2009). "Bonus vetus OLS: A simple method for approximating international trade-cost effects using the gravity equation." Journal of International Economics 77(1): pp. 77-85.

Baier, S. L. & J. H. Bergstrand. (2009): "Bonus vetus OLS: A simple method for approximating international trade-cost effects using the gravity equation." Journal of International Economics 77(1): pp. 77-85.

Chen, C., J. Yang, & C. Findlay. (2008). "Measuring the effect of food safety standards on China's agricultural exports." Review of World Economics 144(1): pp. 83-106.

Disdier, A., L. Fontagné, & M. Mimouni. (2008): "The impact of regulations on agricultural trade: Evidence from the SPS and TBT agreements." American Journal of Agricultural Economics 90(2): pp. 336-350.

Dong, Y. & Y. Zhu. (2015). "Impact of SPS Measures Imposed by Developed Countries on China¡¯s Tea Export-A Perspective of Differences in Standards," Applied Economics and Finance, 2(4), pp. 160-169.

FAO IGG/Tea. (2016). The effects of maximum residue levels in tea on international tea trade. Twenty-second Session. Naivasha, Kenya, 25-27 May 2016

Guo-da Niu Xiao-jing, G. & Q. Zhang. (2007): “Empirical study on the impacts of technical barriers to trade on international trade——Taking tea trade between China and Japan as an example.” Journal of International Trade

Gu, K.J. (2001). The development and application o f the gravity model by using the international economy. World Economy, 2, 14–25.

Guo Qiuting. Impact about the Impact of Green Trade Barriers on theTea Export of Hunan Province [D]. Guangzhou: Guangdong Universityof Foreign Studies, 2017.

Hang, L., Kai, L. (2014-2015): “The influence of cultural exchange on the export of Chinese characteristic agricultural products: Taking China tea export as an example.”

Head, K. & T. Mayer. (2013): “Gravity equations: Workhorse, toolkit, and cookbook.” S.l.:s.n.

Kerr & Gaisford. (2007): “Handbook on international trade policy.” Kerr, W. A & J. D. Gaisford (Eds). ISBN: 978 1 84376 939 2

Leamer, E. & J. Levinsohn. (1995): “International trade theory: The evidence.” In: Handbook of international economics. pp. 1339-1394.

Liu, L., & Yue, C. (2012). Investigating the Impact of SPS Standards on Trade Using a VES Model, *European Review of Agricultural Economics*, *39*(3), 511-528. http://dx.doi.org/10.1093/erae/jbr036

Luo, X.B. (2003). On distance factor in bilateral trade research’s gravity model. International Economics, 2, 45–60.

Jiao Zhiyue and Zhao Lingyun. Impact of Pesticide Residue limit for EU Tea on Chinese Tea Export and the Countermeasures [J]. World Agriculture, 2015, 434 (6): 132-136+22.

Ma Qiang and Qi Chunjie. Empirical Analysis about the Impact of Pesticide Residue limit Standard on the Export Trade of Citrus in the Mainland of China [J]. Journal of Huazhong Agricultural University (Social Science Version), 2013, 108 (6): 53-58.

Martin, W. & C. S. Pham. (2008): "Estimating the gravity model when zero trade flows are frequent." Working Papers eco_2008_03, Deakin University, Department of Economics.

Irshad, M. S., Q. Xin, Z. Hui & H. Arshad. (2018) “An empirical analysis of Pakistan’s bilateral trade and trade potential with China: A gravity model approach” Cogent Economics & Finance, 6(1)

Newton, I. (1999). “The Principia: mathematical principles of natural philosophy.” University of California Press. ISBN 978-0-520-08816-0

Otsuki, T., J. Wilson, & M. Sewadeh (2001). “Saving two in a billion: Quantifying the trade effect of European food safety standards on African exports.” Food Policy (26): 495–514.

Poyhonen, P. (1963). A tentative model for the flows of trade between countries. Weltwirtschaftliches Archiv, 90, 93–100.

Qin, Z., & Ni, Y. (2013). An Empirical Study of the Impact of Technical Trade Barriers on China's Agricultural Exportssince the Establishment of WTO Based on the Two－stage Gravity Model of Multilateral Resistance, *International Economics and Trade Research, 1,* 35-47. (in Chinese).

Robert, D., Orden, D., & Josling, T. (1999). A Framework for Analyzing Technical Barrier in the Agriculture Market,Technical Bulletin 1876, Market and Trade Economics Division, U.S. Department of Agriculture.

Rose, A. K. (2000): “One money, one market: The Effect of common currencies on trade.” Economic Policy, 15(30):

Redding, S. & A. Venables. (2004): “Economic geography and international inequality.” Journal of International Economics 62(1): pp. 53-82.

Santos Silva, J. & S. Tenreyro. (2006): “The log of gravity.” The Review of Economics and Statistics 88(4), pp. 641-658.

Santos-Silva, J. M. C., & Tenreyro, S. (2011). Further simulation evidence on the performance of the poisson pseudo-maximum likelihood estimator, *Economics Letter*s, *112*(2), 220–222. http://dx.doi.org/10.1016/j.econlet.2011.05.008

Santeramo, F. G. & E. Lamonaca. “The effects of non-tariff measures on agri-food trade: a review and meta-analysis of empirical evidence.” Working paper

Schlueter, S.W., C. Wieck, & T. Heckelei.(2009). “Regulatory policies in meat trade: Is there evidence for least trade-distorting sanitary regulations?” American Journal of Agricultural Economics 91(5): pp. 1484-1490.

Schnatz, B. & M. Bussière. (2006). "Evaluating China’s integration in world trade with a gravity model based benchmark." Working Paper Series 693, European Central Bank.

Sigley, G. (2015). Tea and China's rise: tea, nationalism and culture in the 21st century. International Communication of Chinese Culture, 2(3), 319-341.

Sun, D., Sun, W., & Zhou, J. (2007). The impacts of EU's MRL standard on China's tea exports. Nongye Jishu Jingji [Journal of Agricultural Technical Economics], 1,63–71.

Sun, D., Zhou, J., & Yang, X. (2005). Study on the effect of Japan's technical barriers on China's agricultural exports. Nongye Jishu Jingji [Journal of Agricultural Technical Economics], 5, 6–12.

Tinbergen, J. (1962): Shaping the world economy: Suggestions for an international economic policy. s.l.:s.n.

Trefler, D. (1995). The case of the missing trade and other mysteries. American Economic Review pp. 1029-1046.

Victor H. Mair and Erling Hoh (2009). The True History of Tea. Thames & Hudson. p. 262. ISBN 978-0-500-25146-1.

Wang, B., J. Qiu, & X. Tang. (2018): “Analysis of the Impact of EU Pesticide Residue limit Barriers on Chinese Tea Export.” Atlantis Press ..:PP 332-337

Wang Wenjun and Chen Qiong. Research about the Pesticide Residue limit Standard of EU Newest Food [J]. WTO Economic Herald, 2015,137 (2): 90-92

Wei, G., J. Huang, & J. Yang. (2012). "The impacts of food safety standards on China's tea exports." China Economic Review 23(2), pp. 253-264.

Wilson, J., T. Otsuki, 7 B. Majumdsar (2003). Balancing food safety and risk: Do drug residue limits affect international trade in beef? Journal of International Trade and Economic Development 12 (4): pp. 377–402.

Zou, H., & Feng, Z. (2009). The Change Trend and Positive Analysis of Effect of China's Tea Export Trade, *Statisticsand Decision*, *3,* 77-79. (in Chinese)