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Food Standards and Exports

Evidence from China

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Abstract

Using a new database on Chinese food standards, this paper estimates the impact of voluntary and mandatory standards on its agricultural and food exports. The dataset covers seven Chinese products from 1992 to 2008. The findings here indicate that standards have a positive effect on China's export performance. Standards signal to customers that products meet certain quality measures and promote information exchange. The benefits of increased exports outweigh compliance costs. Our results also show that theses positive effects are larger when the standards are consistent with international norms.

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Food Standards and Exports: Evidence from China

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1. Introduction

In this paper, we address the following two questions: Does the introduction of mandatory and voluntary standards affect Chinese exports significantly? What is the effect of international harmonization on agricultural products? The aim of this paper is to attempt to answer these questions by assessing econometrically China's development of mandatory and voluntary standards on its exports of agricultural and food products. We use new data that link Chinese food standards for seven groups of food products (meat, fish, vegetables, cereals, milk, tea, and sugar) to trade data.

Our research contributes to the existing empirical literature in at least three innovative ways. First, we focus on standards implemented by the *exporting* country for its produced goods, whereas previous empirical studies mainly focus on standards used by the *importing* countries. Second, we analyze the impact of standards harmonization in a developing country. Due to data availability, research on the impact of standards harmonization has so far been limited to industrialized countries. To our knowledge, there is no empirical study estimating the impact of national product standards and harmonization in exports from developing countries. Third, our dataset allows differentiation between mandatory and voluntary standards, whereas this was not possible in previous studies due to data limitations. In addition, each type of standard can be identified as being harmonized to international norms or not.

We use an extended gravity model to examine the impact of food standards in China on its agricultural exports. Although estimates vary slightly across products, the results confirm the export-promoting effect of standards. This is particularly true with regard to mandatory standards. In particular, based on our analysis, we confirm the positive impact of standards harmonization. We find that the impact of an additional standard that is based on international measures has a larger impact than the marginal impact of purely Chinese domestic standards. Thus our results provide new evidence on the positive impact of standards on export performance, especially when standards are harmonized to international norms.

The paper is structured as follows. In next section, we review the literature on the trade effects of standards in general, with a focus on the Chinese case. Section 3 discusses the institutional background and recent developments in China's standardization system for food products. In Section 4, we present our data, descriptive statistics, and empirical strategy. We conduct the empirical analysis and present the effects of standards and regulations in Section 5. Finally, we summarize our results and conclude with some policy implications.

2. Literature Review

Standards and Trade

Standards can be differentiated by the freedom of choice regarding compliance (Henson 2004). Mandatory standards are established by public regulators and compliance is obligatory; whereas voluntary standards are often set by standards development organizations, such as the International Organizations of Standardization (ISO) or the Codex Alimentarius Commission, or national standards bodies in a formal process that involves multiple stakeholders such as industry and trade association or consumer organizations. Although their application is not legally binding, voluntary standards can become a 'commercial imperative' or '*de facto* mandatory standard', when producers require suppliers to comply with such standards. A large part of previous literature on standards and trade do not differentiate between mandatory and voluntary standards (Swann 2010).

The literature on standards and trade differentiates the impact of standards set in the importing countries from standards set in the exporting country. The former argue that standards in the importing country can act as barriers to trade. With the reduction of tariffs and quotas governments increasingly use standards to protect their domestic industries. Developing countries are concerned that domestic standards in importing countries – especially in developed countries– increase the cost of compliance and restrict or even prevent market access (Henson, Jaffe 2008). Empirical studies show that the costs of compliance can be important. For instance, Otsuki et al. (2001) estimate a gravity model to show that stringent standards for maximum allowable contamination in fruit and nuts imposed in the European Union lead to significant export losses for African exporters.

At the firm level, Maskus et al. (2004) show that producers from developing countries face substantial investment costs in order to adapt their production processes in compliance with standards in export markets. International trade agreements encourage harmonization of standards across countries. Both the WTO Agreement on Technical Barriers to Trade (TBT) and the Agreement on Sanitary and Phytosanitary Measures (SPS) promote harmonization under the assumption that harmonized standards reduce compliance costs for exporters. Evidence on the trade promoting effect of international harmonization is provided, for instance by Wilson et al. (2003) for beef products. The authors find empirical evidence that if standards were harmonized according to Codex Alimentarius standards, international trade value would rise by more than 50 percent compared to the non-harmonized scenario and developing countries would benefit from harmonization of standards. Portugal-Perez et al (2010) provide similar evidence for electronic products.

Most studies on the impact of standards in the exporting country find a positive trade effect for the exporting country. By providing information on safety levels and signaling quality, standards can help to overcome incomplete or asymmetric information between producers and consumers (Leland 1979). Hudson and Jones (2003) argue that it is particularly difficult for developing countries to signal the quality of their products to consumers. Developing countries can overcome the reputation problem by applying standards. In this sense, standards serve as a quality signal and show consumers that producers in developing countries are able to meet stringent standards and provide safe food products. In a gravity model for agricultural products, Moenius (2006) estimates the impact of domestic and harmonized standards on the exporting country. He finds that the overall effect of domestic standards in the exporting country results in increased trade but the impact of standards harmonization is ambiguous. He argues that the overall effect depends on the balance between reduced compliance costs from harmonization, and the variety reducing effect of harmonization of standards.

Standards and Trade in China

The literature on the trade effects of standards in China largely focuses on standards in countries importing Chinese products. For instance, Chen et al. (2008) examine the impact of maximum residual standards for pesticides imposed by importing countries on Chinese exports of vegetables and aquatic products. Using a gravity model, the authors find a negative effect of safety standards on imports. Yue et al. (2010) analyze the impact of maximum pesticide residue standards for tea imposed by the European Union (EU). The authors find that the introduction of the stringent EU standards significantly decreased exports from developing countries including China. They also argue that the WTO should push the EU to harmonize their standards for tea with international Codex Alimentarius standards.

Songa and Chen (2010) differentiate the short-run and long-run impacts of food regulations. Current food safety regulations notified to the WTO under the WTO SPS Agreement[3] are used to capture the impact of standards in the short-run, whereas two-year lagged regulations capture the impact in the long-run. In the short-run, regulations in importing countries have a negative effect on Chinese agriculture exports, whereas their impact is positive in the long-run. Chinese exporters can cope with foreign regulations in the long-run as they significantly invest in new testing equipment, training and use voluntary standards to meet certification requirements in order to become competitive. The empirical analysis is, however, limited to aggregated exports and a small number of observations.

[3] The Agreement on the Application of Sanitary and Phytosanitary Measures of the WTO (the SPS Agreement) contains provisions to ensure transparency in the development and application of SPS measures. The provisions include the publication -- or notification -- of such measures on the WTO website to inform other members on potential trade impacts.

Bai et al. (2007) and Jin et al. (2008) confirm that Chinese food producers increasingly use voluntary standards. Based on surveys of Chinese firms, the authors argue that improved product quality and safety and access to foreign markets are the main incentives to use voluntary standards and apply for certifications. In the next section, we briefly introduce the institutional background on standardization in China.

3. Food Safety Standardization in China

A number of government agencies are involved in regulating food safety in China: the Ministry of Agriculture, the Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), the Food and Drug Administration, the Ministry of Health, the Administration for Industry and Commerce, and the Standardization Administration of the People's Republic of China (SAC). The large number of agencies with regulatory responsibilities in this area has been subject to criticism as it sometimes leads to an uncoordinated and confusing system (Asian Development Bank 2007). Other problems often cited include low levels of enforcement of standards and regulations by food safety officials and the lack of inspectors supervising an ever increasing number of food producers (Broughton, Walker 2010).

SAC is the agency responsible for approving and publishing Chinese standards and adopting international standards, including food standards. According to Wang Ping, the Executive Governor of the Science and Technology Committee of the China National Institute of Standardization, the standard-setting process in SAC takes place in 450 national technical committees in which stakeholders from government agencies, industry and research organizations participate. SAC nominates the participants and the technical committees are jointly run by SAC and some ministries (Ping 2010). SAC also represents Chinese interests in international organizations. China is actively involved in the Codex Alimentarius Commission (CAC), the organization responsible for setting international standards for food products.[4] Setting food safety standards is a general priority of the Chinese government. In the Eleventh Five-year Plan of Standardization development, agriculture and food safety were named key areas for standardization activities, and the Chinese standardization strategy encourages the adoption of international standards (Ping et al. 2010).

China's accession to the WTO in 2001 and the signing of the Agreement on Technical Barriers to Trade (TBT Agreement) and the Agreement on Sanitary and Phytosanitary Measures (SPS Agreement) provided further incentives to harmonize domestic standards. According to Article 2.4 of the TBT Agreement and Article 3.1 of the SPS Agreement, WTO members are encouraged to use international standards where they exist. Domestic standards that are harmonized to international standards are automatically presumed to

[4] For example, SAC hosts the CAC sector committees for pesticide studies and food additives (WHO 2011)

comply with other obligations of the agreements and are immune from trade disputes in the WTO Dispute Settlement Body. China and other WTO members can decide not to base their domestic standards on international standards. In case a member implements standards considered highly protectionists, it must provide specific justifications for the deviation according to the SPS agreement[5] (Du 2010). Thus, TBT and SPS Agreement do not mandate the use of international standards but provide strong incentives for China and other WTO members to harmonize their domestic standards.

Despite the incentives to adopt international standards, the number of Chinese standards based on international norms remains low compared to other countries. From the total number of standards in our database only 14 percent are based on international norms. In addition, China tends to adopt only parts of international standards, as 70 percent of all harmonized standards in our database are modified versions of international standards. Only one-third of standards in our database are identical to international standards. In the next section, we analyze empirically the impact of standardization and harmonization on Chinese food exports.

4. Empirical Model and Results

Data Sources and Descriptive Statistics

In this section, we describe our dataset and provide descriptive statistics based on the data. Export volumes are compiled from the COMTRADE database at the Harmonized System (HS 1992) and tariffs are compiled from the TRAINS data base. Consumption variables are computed from the Food and Agriculture Organization of the United Nations' statistical database FAOSTAT.[6] We deflated our data US Bureau of Labor Statistic's HS Import Price Indices. The indices are available for the whole period under consideration (1992-2008). The US Bureau of Labor Statistic has no import price deflator for sugar and cereals. We deflate import data for the two product groups with the import price indicator for foodstuffs.

Our dataset covers seven product groups meat (HS-02), fish (HS-03), vegetables (HS-07), cereals (HS-10)), milk (HS-0401 and HS 0402), tea (HS-0902), and sugar (HS-1701 and HS 1702). The seven product categories we cover amount to 40 percent of China's exports in agricultural and food products. There are other important Chinese exports, such as HS chapter 16 "Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates" and chapter 20 "Preparations of vegetables, fruit, nuts or other parts of plants." However, we could not unambiguously link these two chapters to an ICS code since there is only one ICS code for all prepackaged and prepared foods (ICS 67.230 Prepackaged and prepared foods). Moreover, the seven product groups are frequently a target of strict food

[5] Article 2.4 of the TBT Agreement and Article 3.3 of the SPS Agreement.
[6] http://faostat.fao.org/

standards and heavy regulation (Chen and Findlay 2008).Chinese exports in agricultural and food products are increasing. Between 1992 and 2008, total agricultural exports rose from 9.7 to 30.1 billion USD. Exports in the seven product categories represent about 40 percent of Chinese agricultural exports, and went up from 5.1 billion USD in 1992 to 12.1 billion USD in 2008.

The evolution of Chinese exports in the seven product categories is shown in Figure 1. Exports seem to increasingly follow China's comparative advantage in labor intensive product (Fang, Beghin 2000). Labor intensive products –such as vegetables and tea– register large growth rates especially after China's accession to the WTO in 2001. In contrast, exports of land-intensive products –such as sugar, cereal and meat– have increased to a lesser extent. In 2008, China's agriculture exports accounted for about 10 percent of all agriculture exports from low and middle income countries.

[Insert Figure 1 here]

Data on mandatory and voluntary standards are compiled from the Standards Administration of the Peoples Republic of China (SAC), the Chinese official national standards body.[7] Chinese standards developed in SAC are accessible through an online database: the SAC National Standards Query (SAC 2011b). The database has recently been used in Mangelsdorf (2011). To ensure reliability and completeness, the standards have been cross checked with the "Chinese Bulletin of Standards" (SAC 2011a) and the German-Chinese Standards Portal (DIN and SAC 2011). The Chinese National Standards Query provides information on the date the standards came into effect and the date the standards have been withdrawn or replaced by newer versions. Each standard is classified according to the International Classification of Standards (ICS) nomenclature, which allows for matching standards to trade data. The database allows differentiation between Chinese standards harmonized to international norms such as Codex Alimentarius and standards that are unique to China.[8] . International standards in our paper are defined as standards developed by international standards setting organizations (e.g. Codex Alimentarius Commision) which are adopted as Chinese national standards. A concordance table between the seven-digit ICS categories and the trade data in HS codes can be found in Table A.1 in the Appendix. The database allows us to construct four different standards variables according to two criteria: (i) mandatory vs. voluntary standards, and (ii) domestic vs. international harmonized standards.

Table 1 provides some examples to illustrate the different types of standards. The first example, the standard GB/T 19838-2005 for fish and fishery products is a voluntary domestic Chinese standard. It makes companies accountable for analyzing potential hazards

[7] SAC obtained legal recognition by the Chinese government through the Standardization Law of the People's Republic of China from 1988 (source: ISO).
[8] SAC develops mandatory and voluntary standards. The prefix "GB" indicates mandatory standards and voluntary standards are prefixed "GB/T.

regarding the product and establishes control points to ensure food safety (Caswell, Hooker 1996). The standard GB 14939-1994 “Hygienic standard for canned fish” is a mandatory performance standard equivalent to the international Codex Standard 70. Besides process and performance standards, a number of standards are testing standards. For instance, GB/T 22388-2008 is a voluntary testing standard that determines the content of melamine, and GB/T 23376-2009 specifies testing methods for pesticide residuals in tea.

[Insert Table 1 here]

We construct a frequency measure for the four types of standards, which counts the number of standards directly linked to agricultural commodities. Frequency measures or count variables are often used to measure the impact of standards and regulation on trade. The advantage of frequency measure is that they are relatively easy to construct. Yet, these measures may suffer from the so-called ‘mixed bag’ problem, where each standard regulating food safety may differ in the level of stringency and have a different impact on trade. For instance, the “hygienic-performance” standards might have a larger effect on exports than the “testing” standards, or vice versa. Due to the absence of variables indicating the complexity or stringency of the standards, we believe that the number of standards represents a good proxy for the level of regulatory intensity in China and has been widely used in the literature estimating the impact of standards on trade (see for instance Swann (1996), Blind and Jungmittag (2005) Moenius (2006), Portugal-Perez et al. (2010) and Otsuki et al. (2001)).

Figure 2 depicts the evolution of the number of standards in the seven Chinese food products. The stock of active standards is computed as the initial stock before 1992 plus the standards published each year minus withdrawn standards. The total number of standards increases over time. Voluntary standards increased substantially after China’s WTO accession in 2001. The dotted lines in Figure 2 reveal that the share of mandatory harmonized international standards decreased from 10.4 percent in 1992 to 8.9 percent in 2008 whereas the share of voluntary international harmonized standards increased from 9.8 in 1992 to 15.0 percent in 2008.

[Insert Figure 2 here]

Regarding harmonization differences between product groups, Table 2 shows the percentage of Chinese standards that are harmonized to international norms or not. In 1992, for instance, 90.6 percent of Chinese standards for meat products are domestic standards and the remaining 9.4 percent are harmonized to international standards. China seems to be relying more on international standards, as the percentage of Chinese domestic standards is decreasing over time.

[Insert Table 2 here]

Empirical Strategy

In this section, we present the empirical model used to estimate the impact of voluntary and mandatory standards on China's exports. The data allow differentiating between harmonized standards and Chinese domestic standards. We base our empirical model in an extended gravity model widely used in the trade literature (see for instance, Anderson, van Wincoop 2003, Anderson (2011) and Anderson and Yotov (2010)). Similar to Moenius (2006), we focus on a country specific stock of standards in the exporting country and a stock of international standards. Our specification differentiates between mandatory and voluntary country specific as well as international standards.

More specifically, we estimate the equation:

$$\ln X_{ikt} = \beta_0 + \beta_1 StMD_{kt} + \beta_2 StMI_{kt} + \beta_3 StVD_{kt} + \beta_4 StVI_{kt} + \beta_5 Tariff_{ikt} + \beta_6 \ln Cons_{ikt} + \delta_i + \delta_k + \varepsilon_{ikt}$$

where:

X_{ikt} is the value of Chinese exports of product k to country i in year t in dollars;

$StMD_{kt}$ and $StMI_{kt}$ are the stocks of mandatory purely domestic (non-harmonized) and international harmonized standards for product k that are active in year t;

$StVD_{kt}$ and $StVI_{kt}$ are the stocks of voluntary domestic (non-harmonized) and international harmonized standards for product k in year t;

$Tariff_{ikt}$ is the tariff imposed by country i on Chinese exports of product k in year t.

$lnCons_{ikt}$ is the domestic consumption of product k in country i in year t, measured in dollars.[9]

$\delta_i, \delta_k, \delta_t$ are vectors for importer, product dummies, and year dummies respectively.

ε_{ikt} is an error term.

As noted before, previous empirical evidence shows that an increase in the number of standards in an exporting country is positively associated to exports, as information and signaling benefits seem to offset compliance costs. Indeed, standards in the exporting country reduce information asymmetries between producers in China and importers abroad regarding quality and safety levels of food products. Therefore, we expect positive signs in

[9] We computed the consumption of product k in country i and year t as: $C_{ikt} = (S_{ikt} + M_{ikt} - X_{ikt})P_{ikt}$, where S_{ikt} the domestic supply of product k in country i in year t in tones, M_{ikt} [X_{ikt}] stands for import [exports]of product k in country i in year t in tons, and P_{ikt} is the import price of product k in country i in year t in dollars.

the coefficients of Chinese standards variables with, a priori, a larger impact of mandatory standards compared to voluntary standards as compliance with the latter is optional.

Internationally harmonized standards applied by Chinese producers are expected to have a positive impact on exports for two reasons. First, compliance with international standards can be a strong signal that Chinese producers meet safety and quality criteria that are widely recognized. Second, compared to national standards, the informational and signaling benefits of complying with internationally harmonized standards are expected to be larger than complying with national standards.

The coefficient of tariffs is expected to be negative. As a proxy of demand for each product group in each importing country, we include the importing countries' total domestic consumption and its sign is expected to be positive as higher domestic demand is expected to increase the demand for imports from China. To control for unobserved characteristics specific to an importer, such as distance with China or historical linkages, and specific to a product, we include fixed effects for importers and products.

5. Results

The estimation is carried out in a panel covering Chinese agricultural exports to 132 countries over the period 1992-2008. Table 3 summarizes descriptive statistics. Notice that there are fewer observations for consumption and tariff, as data for these variables are sometimes not reported for some goods in an importing country. Yet, coefficient estimates for standards do not change significantly when these variables are excluded from regressions, as shown below.

[Insert Table 3 here]

Table 4 reports OLS estimates for our specification. Column 1 reports the results using the total number of standards as explanatory variable. The coefficient has the expected positive sign and is statistically significant. Column 2 reports estimates from the baseline model

(equation 1). Standard errors are clustered by product groups. All coefficients have the expected signs. Regarding the relative impact of standards, internationally harmonized mandatory standards seem to have the largest impact on Chinese exports. As consumption and tariff data have missing observations for some sectors in some countries, we exclude these variables from the baseline specification. As shown in column 3, estimates of standards coefficients do not change significantly as a result of the omission of tariffs and consumption variables. Importer dummies control for fixed importer-specific characteristics such as distance and historical linkages with China. Yet, some importer-characteristics evolve over time. In order to provide some temporal variation to importer-specific effects, we define 4-year time dummies and interact them with importer dummies, as well as with

product dummies. In other words, these interaction terms will control for average characteristics specific to importers and products varying every four years.[10] Estimates, reported in columns 4 and 5, show that the effect of standards is smaller than in previous estimates, but remains positive. We keep the interaction between the 4-year dummies and the importer and product dummies in next estimates, as they provide more conservative estimates of the impact of standards.

[Insert Table 4 here]

Further robustness checks are reported in Table 5. Column 1 reports estimates carried out restricting the sample to a shorter period 2001-2007, and coefficient estimates are similar. To measure whether the effect of standards is different when the importer is a high-income country, we constrain the sample to include only high-income importers. As shown in column 2, the impact of mandatory standards is not significant for high-income importers, whereas the effect of voluntary standards remains significant.

Standardization could also be influenced by exporters in a particular sector through lobbying, potentially leading to endogeneity of standards due to reverse causality. Previous empirical papers in the literature on standards acknowledge the potential problem of endogeneity and the difficulty of finding a good instrument to address this problem it. However, in the case of Chinese standards, it is unlikely that they are set in response to unexpected surges in food import demand from a single country in a single year, given the complexity and the high number of Chinese agencies involved in making standards. Moreover, standards generation is a time consuming process. It requires the coordination of preferences from various interests groups. In international standardization, the time between the first preposition of a new standard and the final publication can take more than five year (Blind and Jungmittag 2005). In China, the average time to generate a new standard is 4.7 years (Ping 2010). Yet, as another robustness check, we include alternately in our regressions two-year lagged standards variables and report estimates in Column 3. Qualitatively results are the same; standards exert a positive impact on exports with the highest effect for mandatory harmonized standards.[11]

As there are a considerable number of zeroes in the data, it would be desirable to implement a two-stage procedure in which a decision to export a specific product is taken in a first step, then in a second step a decision is taken on volume and destination. In order to satisfy the exclusion restriction typical in such a 2-stage Heckman estimation method, such an

[10] As data on food standards in importing countries is not available, and as suggested by Moenius (2006) in the case of the EU, revision of standards takes place every four years, these interactions would take into account such changes.

[11] As an additional robustness check, we perform a Durbin-Wu-Hausman test of endogeneity of our standard variables in on our baseline model, using the –ivregress- command in STATA. Accordingly, we instrument the standards variables with one-lagged standards variables, and the test results show that we cannot reject the null hypothesis for exogeneity at the one percent level. Estimates of the IV regression are not reported here but can be shared upon request.

approach would require an appropriate exogenous instrument that would influence only the decision to export in the first-stage and not the volume of exports in the second stage. For completeness, we report estimates in Column 4 of a two-stage Heckman model, where no variable satisfies the exclusion restriction.

Finally, we run the threshold-tobit type of model applied by Eaton-Tamura (1994) among others, in the context of gravity models. Indeed, Eaton and Tamura (1994) proposed to estimate a variation of the Tobit model in which the maximum likelihood (ML) function is modified to endogenize the choice of the av parameter, so that the dependent variable is ln(av+ X_{ikt}). Then the ML estimator includes an estimate of the value of av among the set of estimates which means that the dependent variable will be censored at the value ln (av). See Eaton and Tamura (1994) or de Melo and Portugal-Perez (2011) for more details on the estimator. Column 5 in Table 5 reports estimates of the threshold-tobit. As the estimated value for av is close to zero (av= 0000458), estimates are very close to the baseline estimates using OLS. We retain OLS estimates as our baseline estimates here.

[Insert Table 5 here]

Table 6 reports estimates for the seven product groups. The impact of standards seems to vary to some extent but the impact on exports is positive. Mandatory international standards for tea, cereals, and vegetables were excluded from the model because of mulitcollinearity with dummy variables. In the other estimates, however, the variable shows the expected positive sign and is statistically significant for sugar. Domestic mandatory standards are also positive and significant for most product groups. As in the baseline model, the marginal effect for mandatory international standards is larger than the impact of domestic mandatory standards. In other words, one additional international standard leads to more exports than one additional domestic standard. The different results for the impact of mandatory standards might be related to the ability of the standard to provide information on the product characteristic and to serve as a quality signal for potential consumers on the one hand and product adaption costs on the other hand. The ability to provide information on pesticide residues, for example, leads to reduced transaction costs and increases trade.

The impact of voluntary standards is less clear. Domestic voluntary standards are positively correlated with Chinese exports for most product groups but the impact of voluntary international standards is ambiguous. The impact of international standards is positive and highly significant for vegetables and sugar but negative and significant for tea and fish. A plausible explanation for the low impact of voluntary standards is the lack of implementation by Chinese farmers and food producers. Although there is no data on the implementation of voluntary standards, the China Statistical Yearbook of Certification and Accreditation (cited in Jin et al. 2008) shows that in 2005 the number of voluntary food safety standards for hazard analysis and critical control point (HACCP) was implemented by only 21.9 percent of the food producers Assuming that this figure is representative for implementation of voluntary

standards in general, the low impact of voluntary standards in our model can be explained by the low implementation of voluntary standards. Finally, the negative impact of voluntary international standards might be related to the product adaption cost for Chinese firms. Assuming that international standards require higher quality characteristics than domestic standards, Chinese producers face higher adaption costs when foreign consumers demand the compliance with international standards. The sign of the standards in our regression depends on the dominant effect, i.e. quality signaling or product adaption costs. Therefore, the sign for international voluntary standards can be positive (Vegetables, Sugar) or negative (Fish, Tea).

[Insert Table 6 here]

6. Conclusion

The paper provides the first empirical evidence on the impact of Chinese standards for exports of food products. Whereas past literature on the trade impact of standards for developing countries has focused on standardization in the importing (developed) country, we argue that the effect of standards in the exporting country has to be taken into account. In particular, we show that standards harmonization in China has a positive effect on China's exports success.

Our results can be summarized as follows. First, based on new data, our results confirm the trade enhancing potential of standards outlined in previous studies (see for instance Swann 2010). We find that a larger stock of standards in China is associated with expanding exports. Second, we show that the push effect of standards is larger when they are based on international standards such as Codex Alimentarius. Our estimation suggests that one additional internationally harmonized standard in China is associated with an increase in agricultural exports ranging between 0.38 and 0.64 percent.

Third, we find that the effect on trade of standards we examine in the paper s different for voluntary and mandatory standards. The impact of mandatory standards is generally positive and statistically significant for both purely domestic and international harmonized standards. The trade impact of voluntary standards is less clear. Although voluntary domestic standards have a positive impact on Chinese exports in most model specifications, the impact is either smaller or not statistically significant compared to mandatory standards. Among other factors, this may be due to mandatory regulations affecting many more aspects of food products along supply chains.

As we explain, the positive impact of standards is also the result of their role in reducing information asymmetries. Standards -- whether voluntary or mandatory -- increase the

transparency of the food products by providing information such as maximum levels of pesticides to consumers. The impact on trade of international harmonized standards is larger than the impact of purely domestic standards, and this is particularly true for international harmonized mandatory standards. This is due to the signaling effect of international standards regarding quality and food safety. Producers have an incentive to apply standards as they signal their investment in producing high quality products. In the case of Chinese food products, international mandatory standards seem to have a larger signaling effect than purely domestic standards. Foreign customers seem to acknowledge the producers' decision to invest in compliance with international standards.

We conclude the paper by providing the following policy suggestions. First, our results show a larger trade impact of harmonized standards compared to purely domestic standards. Chinese authorities should examine government plans to harmonize domestic food standards. This holds not only for mandatory but also for voluntary standards. Harmonization of food standards is particularly important when Chinese producers want access to foreign markets, especially in developed countries. Second, China and other developing countries should continue to expand their participation in international standards setting organizations such as the Codex Alimentarius Commission. Participation in international organizations allows Chinese stakeholders to include specific national preferences in international norms and may facilitate the adoption of these norms at the domestic level. Third, under the WTO TBT and SPS Agreements, member countries should use international standards where they exist but are free to set domestic standards to fulfill regulatory objectives such as food safety. When developing domestic standards, Chinese authorities could leverage incentives in WTO obligations to expand trade.

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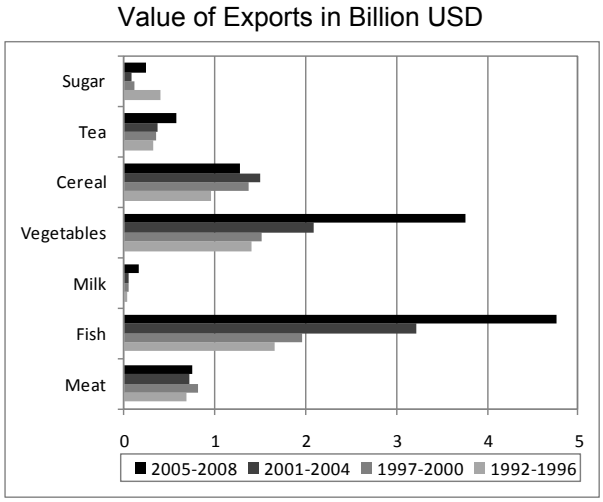
Appendix

Figure 1. Chinese Exports in Agriculture and Food Products



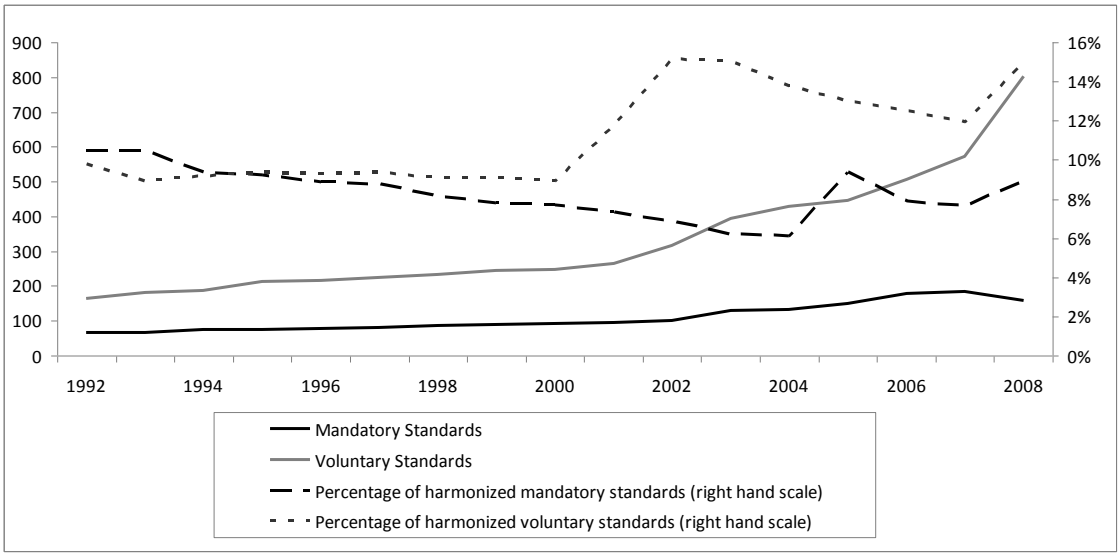
Source: COMTRADE Database, Authors calculation

Table 1. Examples of Chinese Standards

Product Group	Standard	Standard Name	Adopted International Standard	Application Degree
Fish	GB/T 19838-2005	Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application to fish & fishery products	-	-
Fish	GB 14939-1994	Hygienic standard for canned fish	CAC 70:1995	NEQ
Cereal	GB 2715-2005	Hygienic standard for grains	-	-
Meat	GB 19303-2003	Hygienic practice of cooked meat and meat-products factory	CAC/RCP13-1976	MOD
Milk	GB/T 22388-2008	Determination of melamine in raw milk and dairy products	-	-
Tea	GB/T 23376-2009	Determination of pesticides residues in tea - GC/MS method	-	-
Vegetables	GB 2714-2003	Hygienic standard for preserved vegetables	-	-
Sugar	GB 13104-2005	Hygienic standard for sugars	CAC 212:1999	NEQ

Source: Authors' calculations based on SAC National Standards Query

Figure 2. Stock of Voluntary and Mandatory Chinese Food Standards



Source: Authors' calculations based on SAC National Standards Query. The denominator for the percentage of harmonized standards is the stock of mandatory and voluntary standards.

Table 2. Percentage of Chinese Domestic Standards 1992-2008

Product	1992	1996	2000	2004	2008
Meat	90.6	91.4	92.2	92.1	88.9
Fish	100.0	100.0	100.0	100.0	97.0
Vegetables	88.9	84.6	83.7	86.9	83.0
Cereals	100.0	98.9	99.0	98.6	88.7
Milk	73.6	75.4	75.4	75.0	80.5
Tea	100.0	100.0	100.0	75.0	74.3
Sugar	100.0	100.0	100.0	100.0	86.7

Source: Authors' calculations based on SAC National Standards Query

Table 3. Descriptive statistics

Model Variable		Observations	Mean	Standard Deviation
Bilateral exports	$\ln X_{ikt}$	7646	5.98	2.99
Mandatory international standards	$StMI_{kt}$	7646	1.12	1.50
Mandatory domestic standards	$StMD_{kt}$	7646	14.42	9.36
Voluntary international standards	$StVI_{kt}$	7646	4.77	6.22
Voluntary domestic standards	$StVD_{kt}$	7646	42.32	37.03
Consumption	$\ln Cons_{ikt}$	6848	19.82	2.88
Tariff	$Tariff_{ikt}$	6089	0.13	0.16

Table 4. Baseline results

Model Variable		1	2	3	4	5
		all	base	base	base	base
All Standards	St_{kt}	0.009				
		[0.003]***				
Mandatory international standards	$StMI_{kt}$		0.471	0.447	0.386	0.372
			[0.172]***	[0.138]***	[0.276]	[0.247]
Mandatory domestic standards	$StMD_{kt}$		0.027	0.033	0.024	0.02
			[0.010]***	[0.011]***	[0.010]**	[0.010]**
Voluntary international standards	$StVI_{kt}$		-0.006	0.008	0.004	0.017
			[0.013]	[0.012]	[0.015]	[0.014]
Voluntary domestic standards	$StVD_{kt}$		0.004	0.001	0.005	0.003
			[0.004]	[0.004]	[0.004]	[0.004]
Consumption (log)	lnCons	0.089	0.092		0.09	
		[0.041]**	[0.037]**		[0.041]**	
Tariff	$Tariff_{ikt}$	-2.703	-2.486		-2.69	
		[0.316]***	[0.291]***		[0.318]***	
Constant		1.191	1.093	-1.96	1.192	-0.586
		[1.032]	[1.001]	[0.671]***	[1.804]	[1.673]
Observations		5982	5982	8142	5982	8142
R^2		0.49	0.45	0.38	0.49	0.44
Importer and product dummies interacted with 4-year time dummies		Yes	No	No	Yes	Yes

Notes: The dependent variables are bilateral exports. Robust standard errors are clustered by product groups and are reported in brackets. All estimates include importer, product and product dummies interacted with 4-year time dummies. The asterisks represent the level of significance: * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Robustness checks

Model Variable		1	2	3	4	5
		2001-2007	High-income countries	Lagged Standards	Heckman	ET-Tobit
Mandatory international standards	$StMI_{kt}$	0.340	0.322		0.351	0.592
		[0.269]	[0.245]		[0.168]**	[0.136]***
Mandatory domestic standards	$StMD_{kt}$	0.034	0.031		0.018	0.034
		[0.011]***	[0.011]***		[0.016]	[0.011]***
Voluntary international standards	$StVI_{kt}$	0.008	0.014		0.01	0.017
		[0.020]	[0.017]		[0.015]	[0.013]
Voluntary domestic standards	$StVD_{kt}$	0.001	0.006		0.002	0.007
		[0.006]	[0.005]		[0.005]	[0.004]*
Consumption	$lnCons_{ikt}$	0.091	-0.124	0.079	0.093	0.271
		[0.057]	[0.045]***	[0.043]*	[0.026]***	[0.020]***
Tariff	$Tariff_{ikt}$	-2.230	-0.971	-2.734	-2.737	-2.855
		[0.441]***	[1.021]	[0.326]***	[0.248]***	[0.276]***
Mandatory international standards (lagged)	$StMI_{kt-2}$			0.565		
				[0.186]***		
Mandatory domestic standards (lagged)	$StMD_{kt-2}$			0.015		
				[0.011]		
Voluntary international standards (lagged)	$StVI_{kt-2}$			0.04		
				[0.038]		
Voluntary domestic standards (lagged)	$StVD_{kt-2}$			0.005		
				[0.007]		
Constant		1.38	3.271	-0.531	4.059	-0.742
		[2.041]	[1.592]**	[1.092]	[0.616]***	[0.455]
Observations		3224	2304	5673	10530	12247
R^2		0.48	0.67	0.49		

Notes: The dependent variables are bilateral exports. Robust standard errors are clustered by product groups and are reported in brackets. The asterisks represent the level of significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6. Results for Products

Model Variable		1	2	3	4	5	6	7
		Meat	Fish	Vegetables	Cereals	Milk	Tea	Sugar
Mandatory international standards	$StMI_{ikt}$	0.069	0.034	--†	--†	0.123	--†	1.066
		[0.228]	[0.294]			[0.324]		[0.378]**
Mandatory domestic standards	$StMD_{ikt}$	0.03	0.063	0.059	-0.009	0.23	0.003	0.132
		[0.044]	[0.016]***	[0.017]***	[0.118]	[0.137]	[0.011]	[0.205]
Voluntary international standards	$StVI_{ikt}$	0.026	-0.41	0.068	-0.071	-0.516	0.034	1.361
		[0.029]	[0.280]	[0.025]**	[0.079]	[0.686]	[0.017]*	[0.444]***
Voluntary domestic standards	$StVD_{ikt}$	-0.002	0.027	0.001	0.034	0.063	0.002	0.584
		[0.009]	[0.013]*	[0.008]	[0.029]	[0.079]	[0.008]	[0.209]**
Consumption	$lnCons_{ikt}$	-0.503	0.265	0.466	0.072	0.152	0.227	0.108
		[0.287] *	[0.246]	[0.279]	[0.482]	[0.275]	[0.103]**	[0.145]
Tariff	$Tariff_{ikt}$	-0.678	-1.085	-0.788	-3.193	-7.54	0.917	1.176
		[1.341]	[1.245]	[0.691]	[1.857]	[4.753]	[0.473]*	[1.092]
Constant		12.135	-2.493	-5.915	1.081	11.437	1.753	-11.804
		[4.415]**	[3.889]	[6.241]	[7.481]	[11.852]	[1.278]	[3.033]***
Observations		644	768	1209	784	243	1006	901
R^2		0.83	0.89	0.9	0.8	0.71	0.93	0.78

Notes:
The dependent variables are bilateral exports.
The asterisks represent the level of significance: * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors in brackets
All estimates include importer, product and product dummies interacted with 4-year time dummies
† The variable for mandatory international harmonized standards were dropped because of multicollinearity with dummy variables

Table A.1. Concordance Table Between Harmonized Commodity Description and Coding System (HS 1992) and International Classification of Standards (ICS)

Product Name	HS 1992 Chapter	International Classification of Standards Title	International Classification of Standards (ICS) Code
Meat	02	Meat and meat products	67.120.10
Fish	03	Fish and fishery products	67.120.30
Vegetables	07	Vegetables and derived products	67.080.20
Cereals	10	Cereals, pulses and derived products	67.060
Milk	0401, 0402	Milk and processed milk products	67.100.10
Tea	0902	Tea	67.140.10
Sugar	1701,1702	Sugar and sugar products	67.180.10