Contract (in)completeness, product quality and trade – evidence from the food industry

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Abstract

As the recent contributions to the literature show, institutional differences are an important source of comparative advantage. Yet our understanding of the exact mechanisms through which institutions affect trade flows is still rather limited. In this paper, focusing on food sector, we examine a particular channel through which this effect may occur. Using detailed country-product data, we focus on the relationship between the quality of contracting institutions and product quality, which is commonly perceived as a key feature of how countries specialise in production. In line with the existing theoretical arguments, we find that product quality improvements, which can proxy for an adoption of more advanced technologies, are associated with products made in countries-industries characterised by less contractual incompleteness and characterised by greater initial level of technological complementarities between intermediate inputs.

Keywords: contracting institutions, product quality, technology adoption, trade, food industry

JEL codes: F14; L15; O17; O33; Q17

Introduction

The fact that differences in economic institutions are among the main determinants of differences in prosperity across countries is now widely acknowledged (see e.g. North et al., 2009). In line with this belief, there is now a broad evidence showing that institutions may be an important source of comparative advantage. As a consequence, countries with better institutions tend to specialise in institutionally-dependent goods (see e.g. Matsuyama, 2005; Nunn, 2007; Levchenko, 2007; Costinot, 2009; Chor, 2010; Manova, 2013). In particular,

contract enforcement seems to be of special importance, and countries with better contracting institutions are expected to export relatively more in sectors which intensively use contract-dependent inputs. While this finding has been used to explain specialisation patterns across sectors, as we show in this paper, it may also account for international pattern of specialisation within a specific sector. Even more interestingly, we present the evidence that it helps to explain trade patterns for agro-food products, which are commonly argued to belong to the least contract-intensive industries (see e.g. Nunn, 2007).

Having said that, institutions may affect economic outcomes in complex ways (see e.g. Acemoglu et al., 2005; Ogilive and Carus, 2014). There are a number of potential channels through which institutions may exert their impact. Different types of institutions are likely to have distinct effects (Acemoglu and Robinson, 2005; North et al., 2009). In response to this, in this paper we try to see if the documented institutional effect on international trade (Nunn and Trefler, 2014) could be attributed to the impact that contracting institutions may have on technology adoption.

As shown in numerous studies, differences in technology are essential to understand differences in productivity across countries, industries or firms. In line with this evidence, it is commonly argued that cross-country differences in technology are important determinants of international pattern of specialisation and trade (Grossman and Helpman, 1995). At the same time, institutions have long been acknowledged to be an important determinant of technological differences across societies (see e.g. Mokyr, 2002). There are also numerous studies documenting the impact of different institutional features (such as market structure, competition or intellectual property rights) on innovation and technology adoption.[1] Notwithstanding these contributions, our understanding of technology choices, and the impact which institutions may exert on the use of more advanced technologies, is still limited (see e.g. Acemoglu, 2007). Indeed, whereas various theories try to identify crucial determinants and the potential effects of adopting better technologies, studies that empirically test these theories are rather scant.

Having that in mind, in this paper we study how contracting institutions affect the pattern of technological improvements. While doing so, we take into account that this relationship is likely to be sector/product specific, depending on the industries' sensitivity to contractual

[1] Institutional features important in this respect may include, among others, "*the length of patent protection, the coverage of trademark protection or the efficacy with which the legal system protects intellectual property rights and the nature of the regulatory framework within which business firms oprate* (Helpman, 2010, p. 44)".

frictions and the initial level of the technology used in the production process. Our empirical analysis is guided by the theory developed by Acemoglu et al. (2007) who explore how contractual incompleteness together with technological complementarities between intermediate inputs affect the pattern of technology adoption. Our empirical strategy draws on the fact that for many goods the use of more sophisticated technologies can be associated with product quality improvements. In accordance with this observation, in our analysis, we proxy for technological changes with the increases in the quality of an existing product. The latter is inferred using the approach developed by Khandelwal, Schott and Wei (2013).

Our focus is on food sector. The reason for this is that in this sector the issue of product quality seems to be particularly relevant (see e.g. Grunert, 2005; Bontemps et al., 2013). At least partly, this is because of growing concerns about the health and safety of food which were exacerbated by a number of food scares (see e.g. Piggot and Marsh, 2004; Lloyd et al., 2006; Schlenker and Villas-Boas, 2009; or Attavanich et al., 2011). As a consequence, the demand for food becomes more heterogeneous and competition in agri-food markets often switches from price-based to quality-based (Curzi et al., 2015).[2] Looking at the issue of quality upgrading in the food industry could be additionally motivated by the growing internationalisation and interdependence of the subsequent stages of the food supply chain (see e.g. Swinnen, 2007). As a result of these phenomena, quality-contingent contracts became widespread as to assure that this greater complexity of production processes does not place consumers at risk. This in turn clearly suggests that the quality of contracting institutions, which regulate the relationship between food firms and their suppliers, could be of first-order importance for determining quality improvements of agro-food products. While recently there have been many studies investigating the functioning of the agro-food supply chain (see e.g. Swinnen, 2007), our understanding of the organisational design of agro-food production processes, the phenomenon of quality upgrading and its effect on firm performance remain relatively poorly documented. In this paper we try to fill this gap, at least to some extent.

Compared to the existing studies, our analysis provides two main contributions. First, we show that the general finding that contracting institutions could be viewed as a source of comparative advantage holds also for the agri-food sector. This is important since agro-food industries are normally classified as the least-contract intensive ones (see e.g. Levchenko,

[2] In general, quality is often seen as a necessary condition for export success (see e.g. Grossman and Helpman, 1995).

2007; Nunn, 2007). One could argue therefore that for these industries institutional characteristics should not have important impact on international pattern of specialisation and trade. Our analysis provides arguments for the opposite and shows that the quality of contracting institutions seem to be an important source of comparative advantage also within the agro-food sector. Second, and more importantly, we document one possible channel through which this effect may take place. More specifically, we show that institutional characteristics, together with the initial level of technology, might be a key determinant of the increases of the quality of agro-food products. In accordance with the existing theoretical models, we find that quality improvements are observed for product categories characterised by a higher level of initial technology and made in industries which use relatively intensively contract-dependent inputs and countries with strong governance. Importantly, our results are robust to various measures of contract sensitivity at the industry level, to various measures of institutional quality at the country level and to different types of fixed effects included in our models.

Our paper is related to several strands of the literature. First, it tries to contribute to the recently growing theoretical and empirical literature which has identified institutions as an important source of comparative advantage (e.g. Antras, 2005; Nunn, 2007; Levchenko, 2007; Vogel, 2007; Costinot, 2009; Chor, 2010). We differ from these papers as we not only show that institutions may affect the pattern of international trade in food products, but also document a potential channel through which this effect may take place. Other papers related to our work are those by Antras (2003), Antras and Helpman (2008) or Nunn and Trefler (2013). While these papers also study the relationship between contractual frictions and trade, their focus is much different than ours. More specifically, by means of incomplete contract theory, these studies seek to explain the internalisation decisions of multinational enterprises and investigate why some firms source inputs mainly via foreign direct investments whereas other firms source them primarily via outsourcing. None of these papers however is concerned with the impact of contracting institutions on quality upgrading. In addition to the literature already cited, the arguments in this paper are related to recent contributions which try to link institutions, trade and product quality/technology. For example, Fan et al. (2014) show that trade liberalization has led to a surge in imports of intermediate inputs and that the improved access to foreign made inputs has had a large impact on firm productivity and the scope of product offerings at the firm level. Another related paper is that by Essaji and Fujiwara (2012) who test whether contracting institutions affect specialisation in higher or

lower quality goods and find that countries with higher quality institutions tend to export higher-quality varieties of goods. While these papers are similar to ours, they are not concerned with the determinants of quality improvements. Such a perspective is adopted, for example, in the papers by Amiti and Khandelwal (2013) or Curzi et al. (2015). To the best of our knowledge, the latter is the first study which looks for determinants of quality improvements in the food sector. The focus in these studies, however, is much different from ours and is not on institutions and the complementarities between country, industry and product characteristics. Finally, our study naturally complements also a broader literature on the relationship between institutions and trade (see e.g. Anderson and Marcouiller, 2002; Berkowitz et al., 2006; Ranjan and Lee, 2007). The reminder of the paper is organised as follows. In the next section we briefly describe the model which guides our empirical analysis. Further, we present our data and empirical strategy. In the following part we present our results. Finally, the last section concludes.

Theoretical background

In order to show how institutional characteristics may affect differences in technologies and patterns of technology adoption across countries and industries, we follow the framework developed by Acemoglu et al. (2007). The authors propose the model in which a firm decides about the choice of technology (represented as the range of intermediate inputs used in the production process) while taking into account potential contractual difficulties that may arise when dealing with its suppliers. Essentially, the authors' point of departure is the observation that the large fraction of inputs is product specific so that their alternative use is limited. At the same time they make the point that commercial contracts, which regulate business relationships between parties involved in a transaction, are incomplete. This is because they cannot specify all potential contingencies that could arise between firms and their suppliers. Moreover, it is often the case that contract enforcement is not certain and varies with the quality of governance at the country level. All this may importantly affect firms' decisions regarding the organisation of their production processes. In particular, it may influence their decisions about adopting more advanced technologies. Specifically, as argued by Acemoglu et al. (2007), we should observe more advanced technologies being adopted in more contract-dependent industries. Further, this effect should be especially visible for product categories characterised by greater technological complementarity among intermediate inputs.

In brief, the logic and main predictions of the theory which we use to support our empirical analysis can be summarised as follows. In order to improve its productivity, a firm may choose to adopt more advanced technology (defined as the one that leads to the use of a greater range of intermediate inputs). This technological change incurs additional costs of contracting with more suppliers. All activities undertaken by the latter are relationship-specific but only a fraction of those are contractible (i.e. observable and verifiable). As a result, the contract between a firm and its suppliers can stipulate suppliers' investment levels only for a fraction of contractible activities. As far as the investments in noncontractible activities are concerned however, they are unilaterally decided by suppliers in anticipation of the ex post division of revenue. Since suppliers are not full residual claimants of the gains derived from these investments, they underinvest in these activities. The greater the contractual incompleteness, measured as the fraction of activities that are non-contractible, the larger the fraction of activities which receive lower investment level which renders the technology less profitable (as investments in contractible and noncontractible activities are complements).

Interestingly and importantly given our focus, Acemoglu et al. (2007) also show that the negative consequences of contractual incompleteness (positive consequences of high quality contracting institutions) on technology adoption will be more profound when production processes are characterised by greater complementarity among intermediate inputs, which in our context corresponds to higher initial level of technology. In this case, contractual frictions are more damaging since there are greater investment distortions. This is because sectors with greater complementarities among inputs are more contract dependent. Further, in this situation, supplier's payoffs are less sensitive to their noncontractible investments (as marginal reward from these investments depends also on other suppliers' decision to undertake their noncontractible activities). What follows they have lower incentives to undertake them. This makes the more advanced technology less profitable and, consequently, firms have lower motivation to decide for technological improvements.

Overall, the theory which we use to support our empirical investigation provides two main predictions. First, it predicts that greater contractual incompleteness leads to the adoption of less advanced technologies. Second, it allows to assume that the impact of contractual frictions is more pronounced when there is greater level of complementarities among the intermediate inputs, i.e. when the initial level of technology is more advanced. These results suggest that the empirical specification focusing on explaining the impact of contracting

institutions on technology adoption should include the fact that the benefits of better contracting institutions may interact with the initial technologies used in the production process.

It should be added that this discussion is in line with theoretical predictions originating from the work by Aghion et al. (2008) who show that institutions may have differential effects on sectorial performance depending on the specific characteristics of the technology used in the production process. Specifically, they argue that the impact of high quality institutions is strongest for industries using technologies which are the closest to the world's most productive technologies. What should be noted however is that the focus of Aghion et al. (2008) was on democratic institutions and not on contracting institutions. Therefore their results cannot be directly transmitted to our context. That said, their results provide additional rationale for arguing that the initial level of technology may importantly affect the efficiency gains from improving the quality of institutions. This in turn is consistent with predictions derived by Acemoglu et al. (2007) and gives further support to our investigation.

Guided by this theory, we aim at testing the above predictions by looking at the role of specific interaction of country/industry and product characteristics in determining technological improvements. As already mentioned in the introductory part of the text, in our empirical analysis we proxy for the level of technology with product quality and assume that adopting more advanced technologies can be associated with product quality upgrading. The rationale for doing so could be motivated by at least two important reasons. First, the quality of a product would essentially be the outcome of technology used in production. Second, one of the most common form of technological progress involves the introduction of a higher-quality versions of an existing good (compare it, for instance, with Schumpeterian growth models, Aghion and Howitt, 2005). Further, linking the usage of more advanced technology with product quality upgrading can be additionally supported by recent empirical papers showing that better access to intermediate inputs, which is commonly associated with more advanced technologies, results in quality improvements (Amiti and Konings, 2007; Goldberg et al., 2010; Fan et al., 2014).

With this in hand, below we briefly describe our empirical strategy, the data we use in our empirical analysis and the method which we follow to estimate product quality.

Econometric strategy

To test whether contractual incompleteness and technological complementarities matter for technology adoption, we estimate the following equation:

$$\Delta Q_{c,i,j} = \gamma_{imp} + \gamma_{exp} + \gamma_j + \beta lagged Q_{c,i,j} + \alpha lagged Q_{c,i,j} z_i I_c + \delta X_{c,i} + \varepsilon_{c,i} \quad (1)$$

The dependent variable is a 5-year change in product quality (Q) over the period 1997-2002. c, i, j refer to country, BEA industry, and product category respectively. I_c measures the quality of contracting institutions in country c whereas z_i refers to a measure of the importance of relationship-specific investments (i.e. contract intensity) in industry i. The interaction term between $lagged Q_{c,i,j}$, z_i and I_c is included to see whether countries with initial more advanced technology (lagged quality variable), better contracting institutions I_c experience quality improvements (i.e. higher $\Delta Q_{c,i,j}$) precisely in contract intensive industries z_i.[3] γ_{imp} and γ_{exp} are importer- and exporter-fixed effects respectively. γ_j represents product categories fixed effects. To test the robustness of our results we check if our findings change when other types of fixed effects are included (industry-fixed effects; or various interactions between different categories). Lagged quality variable ($lagged Q_{c,i,j}$) is included to control for the convergence process implying that productivity grows systematically faster in industries that were initially at greater comparative disadvantage (Levchenko and Zhang, 2011; Hallak and Schott, 2011). Vector $X_{c,i,j}$ includes observable covariates and these are traditional Hecksher-Ohlin determinants of comparative advantage as well as tariff barriers to capture the fact that trade protection might importantly affect the incentives and thus decisions of firms to improve their technologies or not.

As the theory developed by Acemoglu et al (2007) predicts, β should be larger than zero and thus we expect that larger quality improvements should be observed in countries with better contracting institutions (captured by the interaction between quality of contracting institutions and the sensitivity of an industry to the quality of contracting institutions) and more advanced initial technology (captured by lagged quality variable). Below, we test whether we find this kind of pattern in the data.

Data and quality estimations

[3] Please note that the impact of I_c on quality upgrading is captured by various types of fixed effects which we include in our model. The interaction term therefore allows the marginal effect of contracting institutions on the pattern of technology adoption (quality upgrading) to vary with the initial level of technology.

We use detailed EU-15 import data to identify product and country/industry characteristics which determine the scale of product quality upgrading. Our quality estimation procedure requires the use of data on the price and the volume of exported food products to the EU. Trade data come from the BACI database, which provide information on the value and the volume of traded products at the HS 6-digit level of disaggregation. One major advantage of using these data is that they provide information on FOB (free on board) prices that are obtained through a procedure that compare the declaration of the exporter with that of the importer. This allows having a more reliable measure than traditional trade data that, instead, are based on the declaration either of the exporter or the importer (for a more detailed explanation see Gaulier and Zignago, 2010).

In order to estimate the quality of the exported food products to the EU, we rely on the methodology developed by Khandelwal, Schott and Wei (2013), which is based on the following intuition: "conditional on price, a variety with a higher quantity is assigned higher quality" (Khandelwal, Schott and Wei, 2013). In what follows, we briefly summarize the methodology.

Let us consider the following CES demand function, which define the utility of a given consumer from the consumption of a variety *g* (product *j*, coming from the exporting country *c*):

$$U = \left[\int_{g\in G}[\varphi(g)q(g)]^{(\sigma-1)/\sigma}\,dg\right]^{\sigma/(\sigma-1)} \quad (2)$$

Where *q(g)* and $\varphi(g)$ are respectively the quantity and the quality of the variety *g*, while σ represents the elasticity of substitution. The maximization of (2) under the usual budget constraint gives the demand of consumers for the product *j* coming from the country *c*, yielding:

$$q_{jc} = (\varphi_{jc})^{\sigma-1}(p_{jc})^{-\sigma}P_c^{\sigma-1}\,Y_c \quad (3)$$

where p_{cj} and λ_{jc} are, respectively, the price and the relative quality given by the consumer at the product j exported from country c. The terms P_c and Y_c account, respectively, for the exporting countries' price index and income. Taking the logs of (3), it derives the following OLS regression that allows estimating the quality of the exported products:

$$ln\,q_{jc} + \sigma\,ln\,p_{jc} = \alpha_j + \alpha_c + e_{jc} \quad (4)$$

On the left hand side of equation (4) there are the quantity and the price of product *j* exported from country *c*, while on the right hand side α_c and α_j account for exporter and product fixed effects, respectively. Finally, e_{jc} represents the error term. Quality is then obtained from the estimated residual of (4), and dividing it by elasticity of substitution of country *c* for product *j* minus 1.

$$quality = \hat{\varphi}_{jc} \equiv \hat{e}_{jc}/(\sigma - 1).$$

In order to infer product quality, we estimate equation (4) separately for each importing country-industry pair.[4] Since data on industries contract intensity from Nunn (2007) (see further) are classified at the BEA level, we first map the HS 6-digit trade product categories into their correspondent BEA sector through the use of appropriate concordance tables.

Returning now to the main equation of interest (1), as regards the proxy for contractual frictions, we follow the literature in the way in which we define it. Since there is no unique measure of contractual imperfections we test the robustness of our findings to various measures. First, we use the proxy from Nunn (2007), which is a proportion of each sector's intermediate inputs that are not traded on organised exchanges and thus have higher chances to experience potential contracting problems. Second, we use the proxy from Levchenko (2007), which corresponds to the one minus Herfindahl index of intermediate input use, the idea being that the more inputs used, the more complex is the production of a final good and thus the more sensitive to imperfect contracting institutions it is. Third, we use the proxy from Bernard et al. (2010), who use a weighted average of the wholesale employment share of firms importing goods in a particular sector. One may suspect that contracting is likely to be easier for products passing through intermediaries such as wholesalers. Testing the robustness of our findings to these different measures of contract-intensity is important as it is likely that these different proxies may capture different aspects of, and thus different sources of variation in, product contractibility (Bernard et al., 2010).

The institutional quality variable at a country level comes from the World Bank (2004) and measures the quality of judicial system. It is assumed that the higher the quality of that system the better the ability of a country to enforce contracts. We also test the robustness of our findings to other measures of institutional quality such as that coming from Kuncic (2015).

[4] Elasticities of substitution are taken from Broda et al. (2006). These data provide information for countries elasticities of substitutions at the HS 3-digit level. Following Colantone and Crinò (2014), we took the median over each HS 3-digit category and then we map them into their correspondent BEA sector, using the appropriate concordance tables.

Finally, when testing the robustness of our main specification to the addition of import tariff, we use data from WITS (World Bank) at the HS 6-digit level of disaggregation.

Results

We begin our empirical analysis by replicating some of the key findings in the literature which link the quality of contracting institutions with better export performance to see to what extent these general results hold also for the agri-food sector. To the best of our knowledge, this is the first time that this relationship is tested for this specific setting. Following the approach suggested by Nunn (2007) and later by Nunn and Trefler (2008), we estimate the following equation:

$$export_{c,i} = \gamma_{exp} + \gamma_j + \alpha z_i I_c + \delta X_{c,i} + \varepsilon_{c,i} \quad (5)$$

where $export_{c,i}$ measures export of country c in sector i and the other variables are defined as above. The results of this exercise are presented in Table (1). The left panel uses data at industry level (as in Nunn (2007)), whereas the right panel uses the data at the product category level. Throughout the paper we report beta-standardised coefficients measuring a one standard deviation change in the dependent variable induced by a one standard deviation change in the independent variable. Column (2) presents the results of the same specification as in column (1), but uses a restricted sample of countries/industries as in column (3). This is due to the fact that the data for factor endowments used in column (3) is available only to a limited number of countries/industries. Similarly, in column (5) we re-estimate the specification of column (4) so that the number of observations is the same as in column (6). As reported, the models presented fully confirm findings by Nunn (2007), suggesting that also in food industry better quality contracting institutions promote export especially in sectors which are sensitive to contractual frictions. This is despite the fact that industries from the agro-food sector are commonly defined among the least institutionally dependent industries.

Table 1. Determinants of export performance in food industry

	Exp. Value Industry level			Exp. Value Product level		
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional quality interaction (t-5): $z_i Ic$	0.210***	0.250***	0.255***	0.116***	0.182***	0.162***
	(0.0358)	(0.0475)	(0.0510)	(0.0145)	(0.0198)	(0.0214)
Skill interaction: $h_i Hc$			-0.0112			-0.00730

			(0.0588)			(0.0157)
Capital interaction: k_iK_c			0.0163			-0.0522**
			(0.0801)			(0.0212)
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	No	No	No
Importer	No	No	No	Yes	Yes	Yes
Product FE	No	No	No	Yes	Yes	Yes
N	2880	1705	1705	105177	62094	62094
R-sq	0.645	0.638	0.638	0.232	0.239	0.239

Standard errors in parentheses.

With this in hand, we now move to test whether this effect could be attributed to the fact that better contractual institutions promote product quality upgrading which is commonly perceived as a key feature of how countries specialise in production. We do it by estimating various versions of equation (1). The basic specification reported in Table (2) uses Nunn's measure of contract intensity. Subsequent columns include also other covariates used by Nunn, such as capital or skill intensity of a given industry or various interactions between countries' GDP and the number of industry characteristics (e.g. share of value added in shipments for each industry, the amount of intra-industry trade in each industry, and the TFP growth in the previous twenty years in each industry). This is done to control for the potential that rich countries specialise in certain industries that are characterised by larger quality improvements for reasons other than contractual (in)completeness. Other covariates which we also use include an interaction of the log each country's private bank credit to GDP ratio with each industry's capital intensity (to control for the potential impact of financial development). Column (2) again reports the same specification as in column (1) but using the same sample as in column (3). Columns (1)-(3) use data at the industry level, whereas column (4) uses data at HS 6-digit level.

As shown, these results are fully in line with those predicted by Acemoglu et al. (2007). The coefficient on our interaction term is positive and statistically significant in all specifications. It also remains of similar magnitude across different models. We also find that the process of technology adoption (approximated by our quality upgrading variable) is characterised by a convergence. This is captured by a negative and statistically significant coefficient on a lagged quality variable. In addition, similar to Nunn (2007) we find that institutional aspects seem to dominate the effect of human capital (measured by the interaction between skills and

human capital intensity variable) and physical capital (measured by capital stocks measured by capital intensity at a industry level).

Table 2. Determinants of quality upgrading - baseline specifications

	(1) ΔQ	(2) ΔQ	(3) ΔQ	(4) ΔQ
Product Quality (t-5): Q_{cj}	-0.823***	-0.885***	-0.886***	-0.886***
	(0.0135)	(0.0168)	(0.0168)	(0.0168)
Institutional quality interaction (t-5): z_iIc	-0.0000193	0.00363	0.00352	0.00609
	(0.00694)	(0.00946)	(0.00968)	(0.0112)
Institutional quality interaction * Product quality (t-5): $z_iI_cQ_{cj}$	0.247***	0.312***	0.313***	0.314***
	(0.0142)	(0.0172)	(0.0171)	(0.0171)
Skill interaction (t-5): h_iHc			0.00995	0.00890
			(0.00847)	(0.00947)
Capital interaction (t-5): k_iK_c			0.000843	0.00374
			(0.00906)	(0.0114)
Ln credit/GDP* capital (t-5): k_iCR_c				-0.00264
				(0.00626)
Ln income * value added: $va_{i*}(ln)y_c$				0.0174
				(0.0438)
Ln income * intra-industry trade: $iit_i*(ln)\ y_c$				0.00290
				(0.0338)
Ln income * TFP growth: $TFP_i * (ln)\ y_c$				0.0172
				(0.0277)
Ln income * input variety: $(1 - hi_i) * ln\ y_c$				-0.0213
				(0.0522)
Product FE	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes
Importer FE	Yes	Yes	Yes	Yes
N	75328	46201	46199	55773
R-sq	0.523	0.540	0.540	0.534

Standard errors in parentheses.

In Table (3) we test the robustness of our results to controlling for output tariffs. This could be important as trade protectionism, by reducing or eliminating competitive pressure is often associated with discouraging quality improvements. That said, as the recent evidence shows, the ultimate effect of tariffs on the transition from the production of low-quality to high-quality products is likely to be non-linear (Amiti and Khandelwal, 2013; Curzi et al., 2015). In consequence, in our model except for the direct effect of tariffs we also include the interaction term between tariffs and the initial level of product quality.

Table 3. Determinants of quality upgrading - robustness checks to the inclusion of tariffs

	(1)	(2)	(3)
	ΔQ	ΔQ	ΔQ
Product Quality (t-5): Q_{cj}	-0.873***	-0.883***	-0.884***
	(0.0194)	(0.0256)	(0.0256)
Institutional quality (t-5): Ic	-0.00376	0.0184	0.0174
	(0.00989)	(0.0132)	(0.0137)
Institutional quality*Product quality (t-5): I_cQ_{cj}	0.315***	0.346***	0.347***
	(0.0171)	(0.0211)	(0.0211)
Ln $Tariff_{cj}$ (t-5)	0.00563*	0.0109**	0.0104**
	(0.00303)	(0.00429)	(0.00433)
Ln $Tariff_{cj}$*$Quality_{cj}$ (t-5)	-0.0306***	-0.0815***	-0.0814***
	(0.0106)	(0.0160)	(0.0160)
Skill interaction (t-5): h_iHc			0.0112
			(0.0105)
Capital interaction (t-5): k_iK_c			-0.00168
			(0.0130)
Product FE	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes
Importer FE	Yes	Yes	Yes
N	55773	35348	35347
R-sq	0.534	0.580	0.580

Standard errors in parentheses.

As can be seen, our key variable of interest remains positive, statistically significant at one percent level and of similar magnitude as before. The other results are also unchanged. As regards our additional tariffs variables (linear and interacted), it seems that product quality improvements take place for product categories which are more protected (as indicated by a positive coefficient on tariff measure). This result is somewhat surprising as it is in contrast with the results arguing that tariffs are likely to discourage improving the competitive position and thus quality improvements. It is in line though with an infant industry hypothesis, which suggests that sectors benefit from protection against foreign competition and use this time for strengthening their competitive position. Importantly, this effect is non-linear as the negative

coefficient on the interaction term between tariffs and lagged quality suggests that varieties with higher quality tend to improve its quality further when the tariffs are reduced. This result is in line with other findings for agro-food sector obtained by Curzi et al. (2015).

In Table (4) we test the robustness of our baseline results to alternative measures of contract intensity and institutional quality. What follows we re-estimate the specifications from Table (2) but instead of using Nunn's measure we use now the measure of Levchenko (2007) (columns (1)-(3)) and Bernard et al. (2010) (columns (4)-(6)).

Table 4. Determinants of quality upgrading - robustness checks to various measures of contract intensity and institutional quality

	Herfindal Index			Bernards z index			Inst. Quality from Kuncic		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	ΔQ	ΔQ	ΔQ	ΔQ	ΔQ	ΔQ	ΔQ	ΔQ	ΔQ
Product Quality (t-5): Q_{cj}	-0.562***	-0.533***	-0.545***	-0.672***	-0.768***	-0.770***	-0.662***	-0.715***	-0.715***
	(0.009)	(0.013)	(0.012)	(0.022)	(0.0385)	(0.0383)	(0.0075)	(0.0120)	(0.0120)
Institutional quality interaction (t-5): $z_i Ic$	-0.0104	-0.0143	-0.0226	-0.0474	-0.06***	-0.056**	-0.00042	0.00189	0.00204
	(0.0160)	(0.020)	(0.022)	(0.012)	(0.0226)	(0.0234)	(0.0044)	(0.0063)	(0.0064)
Institutional quality interaction * Product quality (t-5): $z_i I_c Q_{cj}$	0.045***	0.052***	0.051***	0.092***	0.202***	0.202***	0.081***	0.134***	0.134***
	(0.0066)	(0.008)	(0.0078)	(0.023)	(0.0390)	(0.0389)	(0.0079)	(0.0115)	(0.0115)
Skill interaction (t-5): $h_i Hc$			0.0076			0.00827			0.0104
			(0.0086)			(0.0098)			(0.0086)
Capital interaction (t-5): $k_i K_c$			-0.00944			0.0164			0.000557
			(0.0094)			(0.0117)			(0.0091)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	75385	46235	46232	60128	32546	32544	74302	45843	45842
R-sq	0.511	0.517	0.518	0.499	0.499	0.499	0.509	0.510	0.511

Standard errors in parentheses.

The former measure captures the complexity of the production process and is defined as one minus the Herfindahl index of input concentration for each industry. The measure of Bernard et al. (2010) on the other hand captures to what extent inputs sourced in a given industry are

sourced from wholesalers, with the idea being that contracting is likely to be easier for products passing through intermediaries. In columns (7)-(9) we check to what extent our results change if instead of the World Bank data on judicial quality we use an alternative index of institutional quality taken from Kuncic (2015) (the contract intensity measure in the specifications reported in these columns, is taken from Nunn (2007)). As before, our results are robust to these exercises. The main variable of interest remains positive and statistically significant at one percent level. This in turn gives a strong support for arguments claiming that adopting more advanced technologies is dependent on contracting institutions and that this impact will vary with the initial level of technology used in production processes. Specifically, we find that technological improvements can be found in countries-industries with higher quality contracting institutions and product categories characterised by better initial technologies.

Conclusions

It is now known that institutions are important for economic outcomes. In particular, it has been shown that they are likely to determine comparative advantage and thus affect trade patterns. In particular, countries with high quality institutions specialise in products which are institutionally-dependent. In this paper we show that this general belief is also true for the food sector, even though agro-food industries are commonly defined as least institutionally dependent. Further, we differed from the main thrust of this literature and focused on potential channels through which this positive impact of institutions on comparative advantage may take place. Guided by the existing theory, in this paper, we look at the quality of contracting institutions and identify technology adoption (measured by product quality upgrading) as the mechanism through which it may affect international trade. More specifically, we investigate to what extent contractual frictions slow down the process of product quality upgrading.

In line with theoretical predictions developed by Acemoglu et al. (2007) we find that more advanced technologies are highly dependent on a specific interaction between contractual sensitivity, country governance and initial level of technology. Approximating for technology with product quality, we find that technology adoption takes place in countries with higher ability to enforce contracts, industries that are more sensitive to contractual frictions and products characterised by a higher level of initial technology. These results are robust to using different proxies for each sector's sensitivity to contractual frictions and to the addition of various types of fixed-effects.

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