Trading across borders in Central Asia

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Abstract: This paper analyses the economic impact of trade costs on agrifood exports from the Central Asian countries between 2005 and 2017. The study employs a structural gravity model incorporating the World Bank's *Doing Business* indicators for cost to export and time to export to test four hypotheses: (1) remoteness inhibits Central Asian countries' engagement in global trade, (2) cost to export impacts on Central Asian countries more than on the rest of the world, (3) the impact of time to export is higher on perishable as opposed to non-perishable goods, and (4) changing definitions and measurement of *Doing Business* trade costs variables produce different results regarding the impact on export volumes. Initial econometric results for the decade 2005 - 2014 gave strong support to the first hypothesis, but conflicting evidence on the second and third hypotheses. Unexpected results included positive coefficients, in some cases statistically significant, for the relationship between trade costs and exports from Central Asia. Noting that the *Doing Business* methodology was revised in 2016, the models were repeated using data from 2015 to 2017. For perishable goods (tomatoes and grapes) the coefficients on trade costs were negative, statistically significant and with a larger impact in Central Asia than the rest of the world. For non-perishable goods (wheat and cotton) the results were not statistically significant. In sum, more recent *Doing Business* trade cost measurements support better our three hypotheses. The results cast doubt on the suitability of using the pre-2016 *Doing Business* methodology on trade costs in the Central Asian context.

JEL Codes: F13; F14; Q17; Q18; O24.

Key words: agricultural trade; trade costs; gravity model; Central Asia

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Introduction

This paper analyses the economic impact of trade costs on agrifood exports from the Central Asian countries, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, between 2005 and 2017. Trade costs are the direct and indirect costs incurred to move goods and services along the entire supply chain, from the producer's door in the exporting country to the consumer in the importing country. As the country's trade costs increase their comparative advantage in export markets decreases, ceteris paribus. The study employs a structural gravity model incorporating two of the World Bank's *Doing Business* indicators 'cost to export' and 'time to export' to investigate 1) how trade costs alter the volume of agrifood exports 2) if Central Asian countries agrifood exports are more affected by trade costs than the rest of the world (ROW); 3) whether recent changes to indicator definitions and measurement of trade costs variables (*Doing Business* indicator) produce different empirical results for agrifood export volumes.

With tariffs now at historic lows, WTO members and researchers are tackling the next challenge to improve trade flows by lowering trade costs. The 2017 signing the Trade Facilitation Agreement (TFA) has identified that trade facilitation can provide mechanisms to reduce trade costs. The simulations using the gravity model suggest an increase of exports by US$ 1.9 trillion for developing countries in case of full implementation of the 2017 TFA (World Trade Organization 2015). However, the scale and scope of the impact of trade facilitation on trade flows are still debated due to complex and ambiguous nature of the trade costs.

Broadly defined trade costs can be described as the direct and indirect costs incurred by exports along the supply chain. While direct costs are purely fees associated with movement, indirect costs - time and uncertainty - can reduce the quality of goods and subsequently alter the price paid for those goods. Consequently, trade barriers that impact on time are of particular concern to exporters of perishable agricultural products. For example, customs delays negatively impacted on exports in Uruguay, but especially on food exports, as their value declines due to perishability of this commodity group (Volpe Martincus, Carballo & Graziano 2015). Some authors calculated that ad valorem trade costs in agriculture were typically in the range of 50 percent higher than in manufacturing in 2010 at the global level (Arvis et al. 2016).

Trade costs can be divided into three classes based on political barriers: those costs incurred bringing goods to the border within a country; those costs incurred to cross the border; and costs experienced once the border is crossed. Broad definition of trade costs by Anderson, JE and Wincoop (2004) included transportation (freight and time) costs, tariff and non-tariff policy barriers, information costs, contract enforcement costs, legal and regulatory costs, and local (wholesale and retail) distribution costs. Alternatively trade costs can be defined as the difference between the costs of domestic and international trade other than those costs related to traditional trade policy instruments, for example import tariffs (Pomfret & Sourdin 2012). Other definitions lie between these extremes, e.g. including behind-the-border costs such as trade finance or meeting national regulations in the importer country.

A lack of unity on how trade costs should be defined makes it difficult to measure trade costs, and hence how to estimate their impact on trade flows. The first challenge the researcher faces is the availability of the reliable data on trade costs. Commonly used trade cost related indicators in various studies are predominantly based on the indices of the World Bank's Cost of *Doing Business* and Logistics Performance Index, the World Economic Forum's Enabling Trade Index and the OECD's Trade Facilitation Indicators. The number and scope of the indicators is usually restricted to the data availability as well as the specific objectives that the researcher is trying to analyse[1]. Nevertheless, the indicators are subject to the assumptions and limitations, which may be crucial at the results interpretation stage. For example, simple composite indicators such as the World Bank's Trading across borders is easy to use in a regression but may be subject to such concerns as data reliability due to generalisation of the assumptions about the trading good. Moreover, in many cases reported data refer only to businesses in the economy´s largest city and relying on consultancy firms in the capital rather than traders' actual experience in crossing borders. Despite that, these datasets are appreciated by researchers as they have been harmonised across 190 countries, available since early 2000s and are easy to use for analysis.

This paper explores the analytical risks from relying on data without carefully exploring how the data was collected and understanding how collections methods and definitions evolve over time. The article uses The World Bank's Trading across borders indicators from 2005 till 2017 as it provides a key example of these problems. In 2016 the *Doing Business* introduced significant changes to the Trading across borders indicators. Among the changes is relaxation of the assumptions about the traded good, if in *pre*-2016 datasets it was six pre-selected products shipped in 20-foot containers, in the new dataset the traded good was the products of country's comparative advantage (defined by the largest export value) to its natural export partner (World Bank 2016). Moreover, the earlier measurement of the Trading across borders assumed that the

1 For example, some studies focused on aggregated indicators of reflecting the port infrastructure; customs environment; regulatory environment; and e-business infrastructure (Wilson, Mann and Otsuki (2003) and (2005)). Other researchers developed and tested indicators aligned to WTO draft agreement on trade facilitation (Moïsé, Orliac & Minor 2011). While others constructed the trade cost indicators in line with the quality of the 'soft' (policy and institutional environment) and hard (physical infrastructure) dimensions (Portugal-Perez and Wilson (2012)). The literature review shows though, that in most recent papers, authors tend to avoid aggregating the indicators and directly test publicly available indicators (Shepherd in press).

goods are shipped by the sea, implying that calculations of time and cost for landlocked economies included those associated with border processes in transit economies. For the landlocked Central Asian economies this could result in significant overrating of the trade costs, as each of them require at least one transit economy to reach the sea from where the good would be shipped. In the new case study, introduced in 2016, natural trading partners may be neighbouring economies that can be accessed by land. Thus trade is assumed to be conducted by the most widely used mode of transport (whether sea, land, air or some combination of these), and any time and cost attributed to an economy are those incurred while the shipment is within that economy's geographic borders (World Bank 2016). This assumption makes the trade costs indicators more relevant for the Central Asian countries, as most of their international shipments, especially the agrifood trade, are conducted by trucks, railroad or cars intra-regionally, i.e. among the Central Asian countries themselves.

We propose that the new and old collection and calculation methods will create misleading results for trade economists and policy development for emerging economies. Consequently, the data is split into two distinct periods, the first one refers to the years 2005 - 2014 and the second, to the years 2015 - 2017. To test this hypothesis a gravity model is employed to estimate the impact of the cost to export and time to export indicators, the composite indices of the Trading across borders indicator, on exports of perishable and non-perishable agrifood products at the global level compared to Central Asia.

The results contributes to the literature by demonstrating the sensitivity of the trade costs estimates to the changing measurement of the Trading across borders indicators. Apart from that the outcome of this paper may contribute to better understanding how particular policies may benefit agricultural trade flows, as well as inform public policy institutions on the allocation of resources to maximise the overall gain for the agricultural sector in Central Asia from engaging in international trade.

The rest of the paper is organized as follows. The next section provide background on the case study region, as well as overview of the World Bank's Trading across borders indicator. The subsequent sections explain the methods and data analysis approach, followed by the results and discussion section. The paper finishes with concluding remarks and ways forward.

Background

Agrifood trade and costs to export in Central Asia

Central Asia is a land abundant, resources-rich region with favourable climatic and soil conditions providing the potential to become a leading food supplier to the global market. This paper focuses on four Central Asian countries, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan[2]. According to the statements made by representatives of the ministries in interviews, some countries, for example China, are interested in agricultural products from Central Asia as they are attracted by the fact that agricultural production in this region is 'ecologically clean', ' safe' and 'natural' ("Forbes" Kazakhstan 2016). This could add value to the agrifood exports from Central Asian countries, in case of improved conditions to trade. Moreover, changing dietary patterns in China, as well as an extended trade dispute with Washington provides opportunities to Central Asian countries to increase their agrifood market share in China (Reuters 2018).

Since the collapse of the Soviet Union, Central Asian countries have adopted relatively open and liberal trade regimes[3], as well as implemented export diversification policies that include diversification of agricultural exports (FAO 2018b). However, despite the efforts and the significant investments from state budgets into export diversification programs the expected gains for agricultural exporters, have not materialized (FAO 2018c).

Lücke and Rothert (2006) suggested that low exports from Central Asia are largely due to border and behind-the-border trade costs, such as shortcomings in transport and customs procedures. According to the World Bank's Trading across borders index the trade costs have remained high by 2017 (Figure 1). The Trading across borders s index for Central Asian countries was the highest among the Europe and Central Asian countries. On the scale of 1-190, where 1 is the best and 190 is the worst performance, Central Asian countries were respectively ranked 70th for Kyrgyzstan, 102 – Kazakhstan, 148 – Tajikistan and 165 for Uzbekistan. To add transparency to these rankings, on average, in 2017 it cost only $200 US dollars and 15 hours per shipment to export goods from developed OECD countries, but it cost approximately $700 US dollars and 286 hours to export each shipment from Kazakhstan (IBRD & World Bank 2018).

[2] Turkmenistan was omitted from the sample as the World Bank's Doing Business indicators are not available for this country.
[3] With the possible exception of Uzbekistan where trade liberalization gradually started in 2017 only and it is not a WTO member

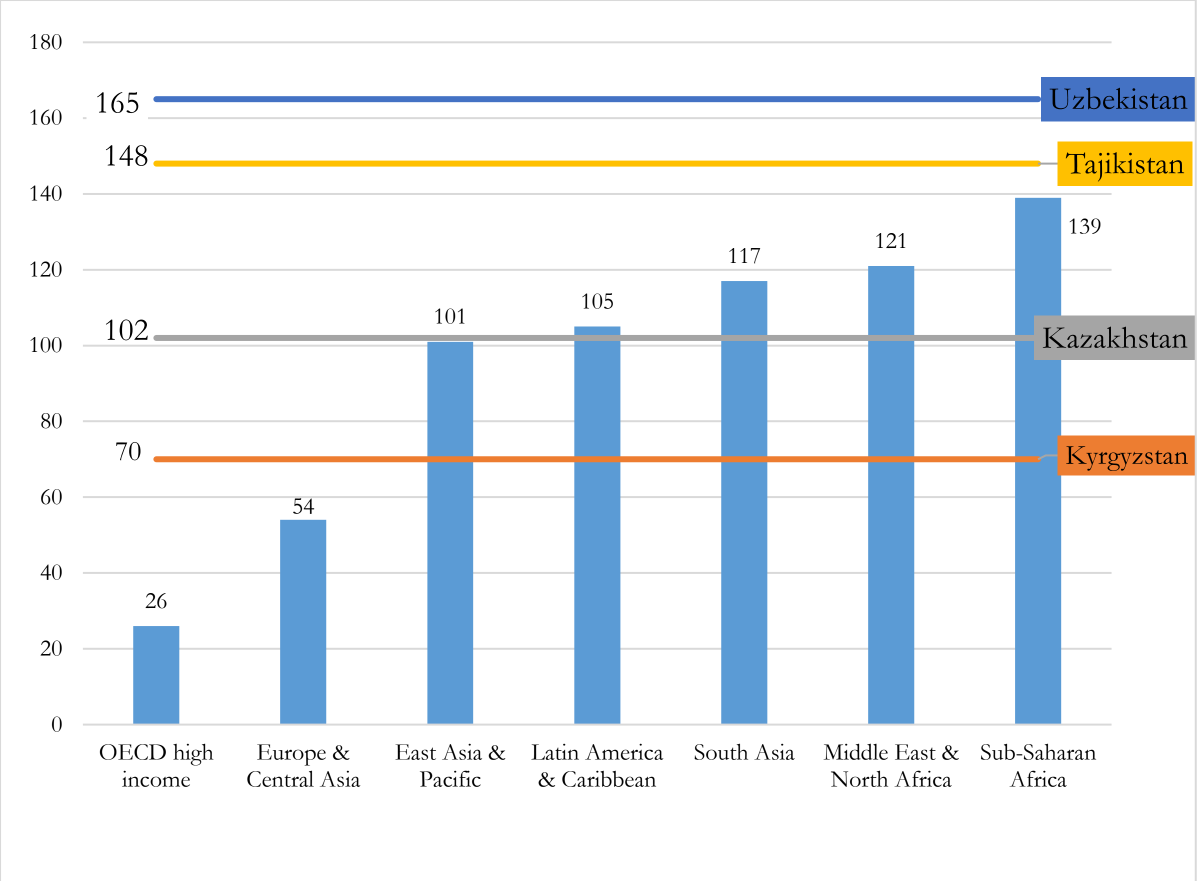

Figure 1 Trading across borders rank in 2017.

Source: Based on the data from the Doing Business reports, 2018

Agrifood products from this region are anticipated to be heavily penalised by high trade costs. As discussed, trade costs include issues associated with transportation, border-clearing, transactions, and other costs associated with fulfilment of non-tariff measures. While traditionally it has been assumed that Central Asian countries' high trade costs would be due to their landlockedness and not having direct access to ports (Raballand 2003), recent literature has challenged that perception and argued that the high costs to trade in Central Asia have been as much due to poor policies and institutions and low quality infrastructure as to geography (Pomfret 2016).

Agricultural goods, in particular perishable ones, are vulnerable to time and uncertainty related trade costs. The geographical and topographical features, including long distances between the main cities (e.g. Kazakhstan), mountain routs (e.g. Tajikistan), ad-hoc administrative hurdles an unreliable train service (Christ & Ferrantino 2011), lack of reliable storage, and refrigeration (FAO 2018a) that add both time, costs and degrade the quality of agrifood exports.

These high costs have changed both the composition, profitability and future of agrifood industries in Central Asia. For example, Uzbekistan used to have a thriving apple export industry during the soviet era, and earlier years after its collapse, but the combination of deteriorated logistics and time delays at customs borders means that its apple exports are now arriving to the Russian Federation at twice the average price of local apple producers (East Fruit News 2018, quoting FAO). This loss of comparative advantage has contracted the Uzbekistan's apple industry. Central Asia's loss of comparative advantage to Russia been significant for agrifood products. For such perishable agrifood commodities as tomatoes and grapes, Russia accounted for 100 percent and 95 percent share of all Central Asia exports of these products respectively but by 2017 Russia only took 28 percent and 20 percent share of exports respectively (Figure 2) (calculations based on the data from Center for International Development at Harvard University 2019).

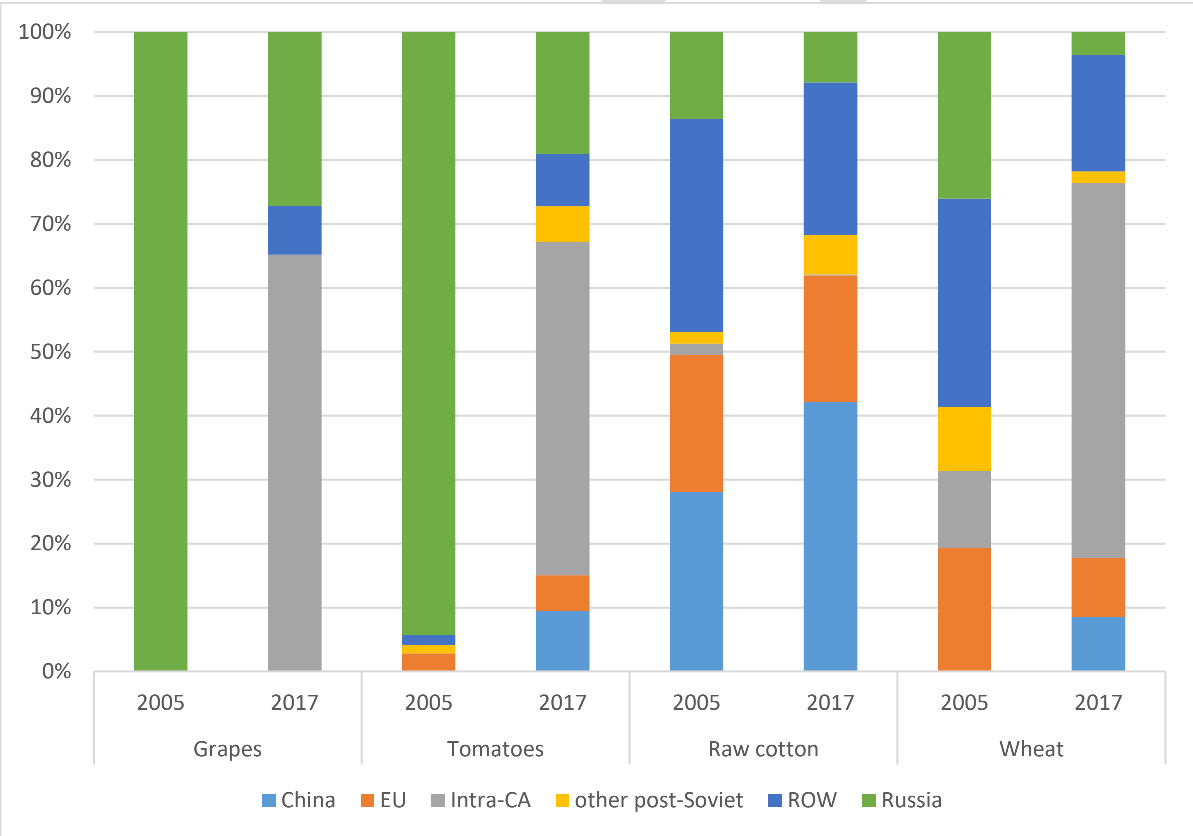

Figure 1 Exports destinations for selected commodities in Central Asia in 2005 and 2017, percent

Source: based on data from the Atlas of Economic Complexity

The exports of these two products to the Russian Federation were largely substituted by the increase of intra-Central Asian trade. Whereas the main suppliers of grapes and tomatoes to the Russian Federation became China, Turkey, some countries of Latin America and other post-Soviet countries, such as Azerbaijan, Moldova and others (based on the data from Center for

International Development at Harvard University 2019). The two relatively non-perishable exporting agrifood commodities in the region, wheat and raw cotton, had more diverse exports destinations as compared to perishables during 2005-2017 (Figure 2).

Logically the reduction in high costs should provide economics benefits. Felipe and Kumar (2012) estimated that aggregated trade in Central Asia may increase by 44 percent from reduction of trade costs, specifically through improvements in the logistics performance index (LPI). In 2017, WTO members signed the Trade Facilitation Agreement that sets up the framework for countries to reduce their trade costs by creating an enabling environment to trade (FAO 2017). Central Asian countries, which are members of the WTO, are obliged to implement Trade Facilitation Agreement and the work is already ongoing (FAO 2018c). However, if the underlying data used can provide false analytics, it may help explain why past reforms have been unsuccessful.

Overview of the Doing Business Trading across borders indicator

This paper estimates the impacts of two trade barriers indicators, time and cost to export, collected by the World Bank and annually published in the *Doing Business* reports. These two variables are components of the Trading across borders indicator that has been available since 2005 in *Doing Business* reports and has been widely used by researchers as they have been harmonised across 190 countries and are easy to use for analysis. Among the studies are Portugal-Perez and Wilson (2009), who used the Trading across borders indicators to construct the aggregated variables reflecting border and transport efficiency, and Lawless (2010) and Dennis and Shepherd (2011) who applied the indicators directly in their studies. Most of the studies focus on the aggregated trade and as expected, obtain significant and negative impact of trade cost on trade flows.

Doing Business measures the time and cost (excluding tariffs and unofficial payments) associated with three sets of procedures - documentary compliance, border compliance and domestic transport - within the overall process of exporting or importing a shipment of goods. These include time and costs for documents, administrative fees for customs clearance and technical control, terminal handling charges and inland transport. The data measurement and assumptions for these two indicators have been changing since the dataset was first introduced (Annex 1).

In 2016 the *Doing Business* report introduced considerable changes to the Trading across borders s indicators to increase their "usefulness for policy and research" (p.32 World Bank 2016). Prior 2016 the standardized case study assumed that the goods were one of six preselected products, shipped in 20-foot containers and trade was assumed to be conducted by sea (World Bank 2009). This was an important limitation for landlocked economies as it would imply that calculations of time and cost included those associated with border processes in transit economies, and thus raising the indicators for landlocked countries. For example, all Central Asian economies are landlocked, and Uzbekistan is double-landlocked, implying that Trading across borders indicator would reflect time and costs associated with transition at least two borders before the good reaches the sea. However, the natural trading partners for Central Asian countries, especially for the perishable goods are the neighbouring countries that can be reached in shorter times and lower costs over the land border. The lack of variation with regard to trading partner and trading product might be especially limiting factor for an analysis at the disaggregated level of export data. The Doing Business Trading across borders indicator for 2005 and 2015, assumes the containerised shipments of goods, which not necessarily, and for Central Asian countries in particular, would be the common way of shipping the agrifood commodities. For example, wheat and cotton could be transported by railways or trucks, whereas fruits and vegetables - by trucks and cars. Thus, relaxation of this assumption in data starting from the Doing Business 2016 might provide more accurate results for the analysis of the impact trade costs had on agrifood exports in Central Asia.

In the new dataset, the data first published in Doing Business 2016, it was assumed that each economy exports the product of its comparative advantage to its natural export partner - the economy that is the largest purchaser of this product (World Bank 2016). Trade is assumed to be conducted by the most widely used mode of transport (whether sea, land, air or some combination of these), and any time and cost attributed to an economy are those incurred while the shipment is within that economy's geographic borders. All of these newer specifications makes it closer to the real trading conditions in Central Asia. Moreover, because the new methodology also allows for regional trade, it emphasizes the importance of customs unions:

"An improvement under the new methodology was recorded for Croatia, which is part of the European Union. In the new case study Croatia both exports to a fellow EU member (Austria) and imports from one (Germany), and documentary and border compliance therefore take very little time and cost as measured by Doing Business" (p.33 World Bank 2016)

Following this example, the Central Asian countries should had also received a better score as they predominantly trading with neighbouring countries, especially agricultural products mostly traded inside the Central Asia, and all of them are the members of the free trade agreements, either

Eurasian Economic Union (Kazakhstan and Kyrgyzstan) or Commonwealth of Independent States Free Trade Area (all four countries).

In the *Doing Business* for 2005 – 2014 the time to trade is recorded in calendar days, starting from the moment when the trading process is initiated and runs until it is completed (data notes from World Bank 2009). It is assumed that document preparation, inland transport and handling, customs clearance and inspections, and port and terminal handling require a minimum time of 1 day each and **cannot take place simultaneously**. Whereas in the *Doing Business* for 2016 and later years, time is measured in hours (1 day is 24 hours) and the "set of procedures for documentary compliance is **potentially simultaneous** with those for domestic transport and is **highly likely to be simultaneous** with port or border handling, with customs clearance and with inspections" (data notes from IBRD & World Bank 2018). Thus we may anticipate an overall reduction of the time to export indicator.

As it would be expected, the new measurement of the Trading across borders indictors resulted in significant improvement of the indicators for some countries. Specifically, looking at the Central Asian countries, it can be noted that time to export in Kyrgyzstan improved by 30 times, from 63 days in DB2015 (reporting the data for 2014) to export to 2 days in DB2016 (reporting the data for 2015), while in Kazakhstan, it changed from 79 days in 2014 to 11 days in 2015.

Finally, the data note in each year's *Doing Business* report states that "contributors are private sector experts in international trade logistics" (IBRD & World Bank 2018). However, for Central Asia a cursory review of the list of contributors' employers (i.e. company name) who potentially could be directly involved in trade and logistics varied between 0 and 19 percent (summary statistics in Annex 2). Notably, the zero share of the company that can be approximated as focused on the trade and logistics is recorded across all the Central Asian countries after 2016. Does this mean that the contributors are only data reporters whereas the actual contributors, people from international trade logistics left unrepresented?

To address the concerns raised in the background section, this paper testing the following hypotheses:

1. Remoteness (measured as a physical distance) of Central Asian countries remains a significant impediment to engagement in global trade;
2. Cost to export have a greater impact on agrifood exports in Central Asian countries compared to the rest of the world;

3. The impact of time to export is higher on perishable as opposed to non-perishable agricultural products;

4. The impacts of cost to export and time to export estimated by gravity models are sensitive to their changing definitions and measurements between 2005-2014 and 2015-2017.

Methods

The study employs a gravity model, a commonly used model to analyse the determinant of international trade. The traditional gravity model is based on analogy with Newton's law of gravitation (Tinbergen 1962). A mass of goods or labour or other factors of production supplied at country i, Y_i, is attracted to a mass of demand for goods or labour at destination j, E_j, but the potential flow is reduced by the total trade costs between countries i and j, T_{ij}^{θ},

$$X_{ij} = Y_i E_j / \mathrm{T}_{ij}^{\theta} \quad (1)$$

Anderson, J and van Wincoop (2003) derived the structural gravity model of trade with multilateral resistance terms under the assumptions of identical Constant Elasticity of Substitution (CES) preferences across countries for national varieties differentiated by place of origin (the Armington assumption). Multilateral resistance terms suggest that trade between two partners is subject to the barriers that each country faces with all its trading partners.

$$X_{ij} = \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} Y_i E_j \quad (2)$$

Where:

X_{ij} is exports in value terms from country i to country j;

E_j is expenditure in country j;

Y_i is production in country i;

t_{ij} captures bilateral trade costs;

σ is the elasticity of substitution across varieties;

P_j is inward multilateral resistance, which captures the dependence of bilateral shipments into j on trade costs across all inward routes;

Π_i is outward multilateral resistance, which captures the dependence of bilateral shipments out of i on trade costs across all outward routes;

Not accounting for multilateral resistance terms in a gravity model can lead to biased parameter estimates. At the estimation stage multilateral resistance terms can be addressed with country-level fixed effects, but one then loses scope for analysis of country-level factors. Most commonly, the model is estimated by Poison Pseudo Maximum Likelihood (PPML) with fixed effects, which collapses the it into the following empirical setup:

$$X_{ij} = exp\left(T_{ij}\beta + \pi_i + \chi_j\right)e_{ij} \tag{3}$$

Where:

T_{ij} is a vector of observables capturing different elements of trade costs;

π_i is a set of exporter fixed effects;

χ_j is a set of importer fixed effects;

e_{ij} is a standard error term.

If a model is estimated with PPML with fixed effects the estimated fixed effects correspond exactly to the terms required by the structural model (Silva & Tenreyro 2006). The estimation strategy follows Yotov et al. (2017) and the benchmark estimation model takes the multiplicative form:

$$X_{ijt} = (\beta_0 + \beta_1 \ln(GDP_{it}) + \beta_2 \ln(GDP_{jt}) + \beta_3 \ln(Trade\ cost_{it}) * RoW + \beta_4 \ln(Distance_{ij}) * RoW + \beta_5 \ln(FTA_{ijt}) + \beta_6 \ln(Landlocked_i) + \beta_7 \ln(Border_{ij}) + \beta_8 \ln(Language_{ij}) + \beta_9 \ln(Trade\ cost_{it}) * CA + \beta_{10} \ln(Distance_{it}) * CA + \eta_{jt} + \mu_{jt} + \gamma_{ij})\varepsilon_{ijt} \tag{4}$$

Where, the dependent variable (X_{ijt}) is the export values in US dollars. Trade costs indicator $\ln(Trade\ cost_{it})$, is the vector of the trade costs indicators related to the definition of trade costs: $\ln(Trade\ cost_{it}) = \{ \ln(Time\_Ex_{it}); \ln(Cost\_Ex_{it}) \}$. Trade costs indicators measured as time to export in days $(Time\_Ex_{it})$ and cost to export in US dollars $(Cost\_Ex_{it})$. Interactions of the trade costs indicators and distance with the variables CA and RoW were used to differentiate the impact on Central Asian countries and on the rest of the world, and thus, address the hypothesis tested. The independent variables include the classic set of trade explaining variables. The GDPs (GDP_{it} and GDP_{jt}) of the exporter and importer in current US dollars, geographic distance ($Distance_{ij}$) between the capital cities of the trading partners. There is also a set of dummy variables such as landlockedness ($Landlocked_i$), common language($Language_{ij}$), common border ($Border_{ij}$) and bilateral trade agreements(FTA_{ijt}).

Data and estimation strategy

The dependent variable is the export value in current US dollars at HS four-digit products classification: grapes (HS0806) and tomatoes (HS0702) standing for the group of perishable commodities; wheat (HS1001) and cotton (HS5201) - non-perishable products.

All the 'classic' variables, GDPs, distance, common border and language, Free Trade Agreement (FTA) and landlockedness, come from CEPII database[4].

Trade cost variables are the time and cost to export components of the *Doing Business Trading* across borders indicator. The datasets are separated into two time periods 2005 - 2014 (reflecting the earlier version of Trading across borders methodology) and 2015 - 2017 – to analyse the effect of the updated methodology of data measurement in *Doing Business.*

Table 1 Data and sources

Variable	Definition	Notation	Source
Exports (dependent variable)	Exports from country i to country j in time t Perishable: grapes (HS0806); tomatoes (HS072); Non-perishable: wheat (HS1001); cotton (HS5201)	X_{ijt}	Atlas of Economic Complexity
Common language	Dummy variable equal to one for countries that have a common official language.	$Language_{ij}$	CEPII
Landlocked	Dummy variable equal to one if country is landlocked.	$Landlocked_i$	CEPII

[4] The Centre d'Études Prospectives et d'Informations Internationales, http://www.cepii.fr/CEPII/en/cepii/emploi.asp?IDemploi=11

Distance	Population weighted distance between country i and country j.	$Distance_{ij}$	CEPII
FTA	Dummy variable equal to one for country pairs that are members of the same regional trade agreement.	FTA_{ijt}	CEPII
GDP	GDP of exporter in current US$ dollars	GDP_{it}	CEPII (2005-14) World Bank (2015-17)
GDP	GDP of importer in current US$ dollars	GDP_{jt}	CEPII (2005-14) World Bank (2015-17)
Time to export	Number of days to export 20-foot container (2005 – 2014), and unit of shipment (2015 - 2017)	$Time\_Ex_{it}$	World Bank *Doing Business* database
Cost to export	US$ dollars to export a 20-foot container, and a unit of shipment (2015 - 2017)	$Cost\_Ex_{it}$	World Bank *Doing Business* database
Central Asia	Dummy variable equal to 1 if exporting country is Kazakhstan, Kyrgyzstan, Tajikistan or Uzbekistan	*CA*	
Rest of the World	Dummy variable equal to 1 if exporting country is not *CA*	*ROW*	

The estimation approach was as follows. A benchmark model (equation 4) is estimated with PPML exporter-year, importer-year fixed effects to control for multilateral resistance terms[5]. The exporter-year and importer-year fixed effects that are commonly recommended by the literature absorb the estimates for all the time varying variables, including trade cost indicators. Despite that, the theory consistent coefficients for time invariant variables obtained in such a set up play as a benchmark for all other estimation techniques.

[5] All the regressions were run using the specific STATA command developed by Correia, Guimarães and Zylkin (2019) for high dimensional fixed effects with PPML. The OLS was estimated at the early stage of the analysis, but, since the literature consensus is in using the PPML, only results obtained with PPML are presented in this paper.

The next step was to estimate the model with exporter, importer and year fixed effects only, which resulted in close estimates for time-invariant variables compared to the benchmark results. Thus it is safe to assume that such an approach would provide results similar to the theory-consistent outcome. Therefore, the results reported in this paper are obtained from the PPML estimator with exporter, importer and time fixed effects.

A panel dataset with only positive export values for four periods (2005, 2008, 2011, and 2014) was used instead of consecutive years for the 2005-2014 dataset analysis. This approach allows for adjustment in bilateral trade flows in response to trade policy or other changes in trade costs (e.g.Yotov et al. 2017). The model estimated separately for each product. Number of observations in each dataset varied between 5,443 and 9,963, with 140 exporters and 180 importers on average for the selected four products (summary statistics in Annex 3).

The similar approach was used to estimate the impact of trade costs based on the data from 2015-2017. However, due to the small number of years in the panel, consecutive years, instead of periods were used. The number of observations for this period varied from 3,320 to 6,813. Also, the regression was run twice for each product, with cost to export and time to export indicators appearing separately in the models, to avoid the multicollinearity problem (summary statistics in Annex 4).

Results and discussion

Table 2 reports estimates for the perishable and non-perishable products groups for 2005-2014, each product group at HS 4-digit level, using the PPML with exporter, importer, and year fixed effects. Column (1) reports estimates for tomatoes, (2) – grapes, (3) and (4) – wheat and raw cotton respectively.

Generally, the standard gravity variables are statistically significant and have the signs expected in gravity models. Export values are positively related to partners' GDP and negatively related to distance. The trade policy variable, FTA between trading partners plays a positive and statistically significant role for exports of the perishable products, however, coefficients are not significant for the group of non-perishable commodities, wheat and raw cotton. The key variables that were tested under the hypotheses: distance, cost to export and time to export resulted in mixed, sometimes controversial outcomes.

The estimation results have proven some of the hypotheses that have been tested. First, indeed, results support that long distances to meet global markets play a significant role for Central Asian countries' agrifood exports. The effect of longer distance in Central Asia as compared to the outcome at the global level is three times higher for exports of grapes, two times higher for wheat and raw cotton and almost the same level for tomatoes. This explains the reliance of Central Asian countries on intra-regional trade. As expected, some perishable products, such as grapes, are more sensitive to longer distances in Central Asia, than non-perishable products. The results suggest that a one percent longer distance between the Central Asian country and its trading partners reduces the exports of grapes by 2.9 percent, or raw cotton by 1.7 percent.

However, the answers for the second and third hypotheses are not straightforward. The coefficients for the trade costs indicators, cost to export and time to export, have resulted in mixed outcomes, some of which are contrary to expectations, others – not significant.

The second hypothesis tests, whether higher cost to export has a stronger impact on trade in Central Asian countries than on the rest of the world. However, the trade cost coefficient result is only significant and negative for exports of tomatoes at the global level, implying 1 percent increase in trade cost would lead to 1 percent decrease of exports of tomatoes. Controversially, the results for raw cotton for Central Asia are positive and significant, implying 1 percent increase of trade cost would lead to 1 percent increase in exports value of raw cotton. Thus, with such a mixed and theory inconsistent outcome it is difficult to confirm if Central Asian agrifood exporters suffer more than global exporters by facing higher costs to export.

The explanation of such results may be due to the assumptions behind the cost to export indicator. This indicator is based on a full 20-foot container of dry-cargo, loaded with economy's leading export products and shipped by the sea. Such a precise specification excludes the heterogeneity of the trade costs options. Especially, perishable agricultural commodities where refrigeration might be required.

Moreover, a positive relationship between exports value of raw cotton and the cost to export indicator may be due to specifics of raw cotton trading procedures. In Uzbekistan, for example, these are state orders that are then exported directly to China, despite any costs incurred on the way to the border.

Finally, the results are also not sufficient to prove the third hypothesis, whether the impact of time to export is higher on perishable as opposed to non-perishable goods. Time to export is negative and significant only for perishable products, tomatoes and grapes, at the global level. The results are not significant for non-perishable group. In Central Asia time to export is only significant with a high, positive coefficient for wheat, implying a longer times leading to greater exports values of wheat. This result may be due to: 1) assumptions about the traded-good; 2) the mode of transport specified in the Trading across borders case study. The Trading across borders measurement assumed that the good is 1) containerized 2) shipped by the sea. None of which applies well for Central Asia, where wheat it is usually send by trucks or railroads, not in containers.

Moreover, in the case of the landlocked countries, for good to be shipped by the sea, it must past at least one extra border before reaching the sea port. However, this implies overestimation of the trade costs of Central Asian wheat, where up to 50 percent is traded once it crosses the border. Therefore we obtain a positive association between time indicator and exports of wheat, providing nonsensical results. Apart from this, a lack of variation in the value of exports from Central Asia by export market for each of the selected product could also be a reason of such theory-inconsistent results.

Table 2 Gravity model results for perishable and non-perishable products at HS 4-digits level estimated with PPML exporter, importer and year fixed effects, 2005-2014

	(1) Tomato (HS 0702)	(2) Grapes (HS 0806)	(3) Wheat (HS 1001)	(4) Raw_Cotton (HS 5201)
ln_gdp_o	0.153	0.335	0.220	0.350
	(0.225)	(0.162)**	(0.212)	(0.256)
ln_gdp_d	1.125	1.043	0.250	0.468
	(0.230)***	(0.149)***	(0.163)	(0.276)*
RoW_distance	-1.619	-0.875	-1.333	-0.819
	(0.211)***	(0.137)***	(0.125)***	(0.163)***
RoW_cost	**-0.898**	0.067	-0.014	0.036
	(0.205)* **	(0.140)	(0.272)	(0.241)
RoW_time	**-0.400**	**-0.276**	-0.011	-0.885
	(0.199) **	**(0.121)** **	(0.202)	(0.549)
CA_distance	-2.030	-2.912	-2.127	-1.671
	(0.918)**	(0.409)***	(0.475)***	(0.626)***
CA_cost	1.134	0.769	-0.306	**0.914**
	(1.037)	(0.515)	(0.838)	**(0.293)*** **
CA_time	1.014	-0.443	**5.341**	1.552
	(1.271)	(1.573)	**(3.081)* **	(2.203)
contig	0.096	0.567	0.359	0.616
	(0.241)	(0.194)***	(0.162)**	(0.277)**
comlang_off	1.464	0.124	0.197	0.066
	(0.486)***	(0.172)	(0.174)	(0.305)

comcol	1.145	-0.141	0.625	0.379
	(0.461)**	(0.385)	(0.249)**	(0.287)
fta_wto	1.242	1.200	0.082	-0.010
	(0.295)***	(0.154)***	(0.141)	(0.167)
intra_EU	1.162	0.372	0.311	0.605
	(0.415)***	(0.262)	(0.299)	(0.344)*
_cons	-0.917	-14.695	16.162	3.924
	(9.466)	(6.125)**	(7.502)**	(8.188)
N	5443	9963	6392	6459

Standard errors in parentheses

* $p < 0.10$, ** $p < .05$, *** $p < .01$

Standard errors clustered by country_pair

Data note: dependent variable export_value>0; exporter, importer, year fixed effects

To address the fourth hypothesis that changing definitions and measurement of the same trade cost indicator from period to another affects the gravity model results the models were re-estimated for using data from 2015 to 2017. Table 3 reports the trade cost and distance related results. The distance related variable is in line with expectations with somewhat higher coefficients as compared to the previous period results.

The trade costs variables reveal striking results. For Central Asia cost to export is turned to be highly negative for both tomatoes and grapes at 1 percent level of significance, implying that 1 percent increase of cost to export would result in 16 and 12 percent decrease in exports of these products, respectively. Moreover, the impact of high trade costs on export of grapes is four times higher for Central Asia as compared to the rest of the world.

Finally, the time to export is only negative and significant for the exports of grapes in Central Asia, implying that a 1 percent increase of time to trade would reduce grapes exports by 6 percent. This can be translated as any two hours delay on the way to the border, would cost a Central Asian grapes exporters almost $10 million US dollars (calculation based on the 2017 data). At the global level, results are only significant and positive for raw cotton. Overall, the drastic change of the signs and the trade cost coefficients demonstrate high sensitivity of the gravity model results regarding the impact on export volumes due changing definitions and measurement of trade costs variables. The results allow to confirm the hypothesis tested that gravity estimates are sensitive to the changing trade cost measurement and result in more theory-consistent outcomes. Changed definition of the exporting good to the product of comparative advantage allows to count for greater selection of the products at disaggregated level. Next, extension of the assumption about the transportation mode from the containerised sea shipments to ‘the most widely used for the chosen export product (truck, train, or riverboat)’ and assuming a ‘natural’ partner provide more relevant indicators for landlocked countries. This is an important improvement for the analysis of Central Asian countries, where the goods, agrifood in particular, are traded by trucks and railroads and most of the trade, especially of the perishable products, occurs intra-regionally.

These findings raise the questions about the past policy formulation based on the 2005-2014 Trading across borders data. It is logical to assume that resource misallocation may have occurred and the outcome of trade costs reduction policy will have been less than anticipated.

Table 3 Gravity model results for perishable and non-perishable products at HS 4-digits level estimated with PPML exporter, importer and year fixed effects, 2015-2017

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Tomato1	Tomato2	Grapes1	Grapes2	Wheat1	Wheat2	Raw_Cotton1	Raw_Cotton2
RoW_distance	**-2.886**	**-2.886**	**-1.165**	**-1.165**	**-0.997**	**-0.997**	**-1.002**	**-1.002**
	(0.262)***	**(0.262)*****	**(0.162)*****	**(0.162)*****	**(0.163)*****	**(0.163)*****	**(0.171)*****	**(0.171)*****
RoW_cost	0.849	0.849	**-2.281**	**-2.280**	**-1.971**	**-1.981**	0.842	0.857
	(1.577)	(1.578)	**(0.707)*****	**(0.707)*****	**(0.717)*****	**(0.717)*****	(1.163)	(1.164)
RoW_time	-0.091	-0.091	-1.334	-1.332	0.338	0.340	**1.821**	**1.830**
	(0.591)	(0.591)	(1.270)	(1.270)	(0.302)	(0.302)	**(0.761)****	**(0.761)****
CA_distance	**-3.115**	**-3.115**	**-2.448**	**-2.447**	**-4.241**	**-4.244**	**-1.273**	**-1.270**
	(1.474)**	**(1.474)****	**(0.578)*****	**(0.578)*****	**(0.761)*****	**(0.761)*****	**(0.632)****	**(0.629)****
CA_cost	**-16.007**		**-12.237**		0.413			2.407
	(0.746)***		**(4.083)*****		(0.751)			(3.353)
CA_time		-69.169		**-6.338**		0.837	4.028	
		(70.047)		**(2.962)****		(7.773)	(3.087)	
N	3320	3320	6813	6813	3828	3828	3538	3538

Standard errors in parentheses * $p < 0.10$, ** $p < .05$, *** $p < .01$

Standard errors clustered by country_pair

Data note: dependent variable export_value>0; exporter, importer, year fixed effects

Conclusion

The goal of the paper was to analyse the impact of the trade costs on exports of agrifood products with a focus on Central Asian countries. The rationale for this study is that reduced trade costs, or trade facilitation, can improve comparative advantage of these countries to export agrifood products and thus benefit both the region itself as well as the global society. Specifically, the impact of trade costs was estimated for the disaggregated at HS 4-digit level perishable (grapes and tomatoes) and relatively non-perishable (wheat and cotton) products. The study employed the World Bank's Trading across borders indicators such as time and cost to export. Despite some criticism, these indicators have been widely used to analyse the impact of trade costs on the international commodity flows, mainly because they are harmonised across 190 countries and have been published since 2004, making them convenient to use and analyse.

The structural gravity model for international trade was used for the analysis. Contrary to expectations, the estimation analysis revealed mixed and sometimes theory inconsistent results across the products as well as the across trade costs indicators that were used. Some proven the hypotheses tested, confirming that distance and cost to export has greater impact in Central Asia compared to the world, as well as suggesting that perishable products are more sensible to time delays than non-perishables. However, the cost to export coefficients for some products had positive significant signs, implying that the higher trade costs exporters face the more they trade, and does not make any sense. Moreover, testing the newer, improved methodology *Doing Business* trade costs data revealed more theory consistent results as compared to the earlier datasets.

Thus, the findings suggest that the gravity model and *Doing Business* trade costs indicators, especially the *pre*-2016 data, may work well for some countries and some groups of the products but are not always well suited for the disaggregated agricultural products and not for Central Asia, where logistics of agrifood commodities may differ from global practices. Therefore, the next stage of the research is to find alternative data sources and estimation techniques, if required, to estimate the impact of trade costs on perishable and non-perishable products in Central Asia.

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