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Full Length Research Paper

Econometric analysis of consumer preferences and willingness-to-pay for organic tomatoes in Palestine: Choice experiment method

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This study aimed to examine consumers' willingness to pay a premium price for several environmental attributes of organic tomato to increase both producer production and consumer health in Palestine. The paper adopts the choice experiment method using the econometric analysis of the random utility model. The research questions of this study focus on awareness of the importance of ensuring / securing the environment, how many households in the West Bank purchase organic tomatoes, reasons for which households may be willing or not willing to pay more for organic tomatoes, and the main socio-economic variables that affect the households willingness to pay for organic tomatoes when making organic tomatoes choices. The empirical results show that organic tomatoes are preferred to conventional ones because of health claims by respondents so that we conclude that respondents are willing to pay more for organic tomatoes compared to conventional ones. Additionally, consumers prefer organic products because of health and environmental benefits. Some policy measures might further promote the consumption of organic products. These include creating awareness of the relevance of consuming organic products through effective marketing and educational campaigns. However, there are about 500 organic farms in Palestine with a total area of 1'0000 square meters mainly under fruit, almond, olives and dates. According to the Palestinian Agricultural Relief Committee, organic pasturelands are not found because of the Israeli control (German Development Agency GTZ) and according to the ministry of agriculture in Palestine, there are 24 organic olive farms with a total area of 18885 square meters.

Key words: Econometric Models, Choice Experiment Method, Mixed Logit Model, Palestine, Willingness to Pay.

INTRODUCTION

Organic agriculture can be a profitable, sustainable business for agricultural producers interested in going

through the certification process necessary to enter this market (Annunziata and Vecchio, 2016). The Willingness to Pay (WTP) is highest for organic certification label certified by NGOs attribute and lowest for Viet GAP vegetables without a label (Thai and Pensupar, 2015). Moreover, many consumers are willing to pay a premium price for organic tomatoes (Engjell et al., 2017). Organic foods have been expanded during the last few years, and industry experts are forecasting steady growth of 9 percent or higher (Organic Trade Association (OTA), 2015).

However, adoption and development of certified organic farming is not an easy option for farmers, and they face technical, economic, social, cultural and legal barriers. In Jordan and Tunisia, with the technical and financial support of the German Development Agency (GIZ), a series of projects were implemented to gradually eliminate the use of chemical fertilizers and pesticides in agricultural production. The International Federation of Organic Agriculture Movements (IFOAM) (2014), in Jordan, explored that there are diverse organic farms with a total area of 25,669,000 square meters; the shares of these farms in the total agricultural land are equal to 0.25%, and there are 98 producers of organic agriculture. The Israeli agricultural sector is characterized by an intensive production system; this is to overcome the scarcity of natural resources, particularly water. The high-level development of the agricultural sector results in the cooperation between scientists, extension advisers, farmers, and agriculture-related industries. These four elements merged to promote advanced technologies in all agricultural branches. As per IFOAM (2014), Israel has diverse organic farms with a total area of 70,950,000 square meters; the shares of these farms in the total agricultural land are equal to 1.36% and with 500 producers of organic agriculture. On the other hand, Awad (2012) uses the econometric analysis of willingness-to-pay to investigate the efficiency and equity of domestic water services in the West Bank. The critical result reveals that efficient allocation mechanisms based on WTP with key socioeconomic variables suggested by economic theory and CV previous studies are nonexistent in Palestine.

Regarding Palestine, agriculture is one of the most critical sectors of the economy as it employs about 31.9% of the population (Palestinian Central Bureau of Statistics (PCBS), 2013). There are about 500 organic farms in the country with a total area of 10,000 square meters mainly planted in fruit and vegetables, almond, olives, and dates. According to the Palestinian Agricultural Relief Committee, organic farms are not widespread due to the dominance of the occupation of the agricultural lands in the Palestinian territories (GIZ, 2014).

According to the ministry of agriculture in Palestine, there are 24 organic olive farms with a total area of 8,964.8 square meters.

The hypothesis might be that organic food increases the capacity of living organisms towards resilience. However, effect studies on specific markers for health are necessary to be taken into consideration for future research (Huber et al., 2011). The impact of organic fruits and vegetables on human health is considered to be the main contributor to the increased demand for this kind of product. Also, consumers are increasingly interested in the health benefits of foods and have begun to look beyond the primary nutritional benefits to the potential disease prevention and health-enhancing compounds contained in many foods. This interest combined with a better understanding of how diet affects diseases, rising health-care costs and lifelong expectancy are driving a growing and robust market for organic foods and natural health products.

Some researchers have emphasized (Agriculture and Agri-Food Canada, 2009) the health benefits of tomatoes, which is the topic of this paper. Tomatoes are chosen for some reasons: First, other than olives, tomatoes are dominant in the organic food sector, and tomatoes are widely consumed among the Palestinian people. Second, organic tomatoes play an essential role in improving public health for both present and future generations. Third, increasing the level of environmentally-friendly food consumption in households is an essential element that can be utilized in the safeguarding of the environment and may reduce Greenhouse Gas (GHG) emissions. Fourth, in the West Bank, the willingness to pay for organic tomatoes is widely discussed and is becoming more relevant to the business in the West Bank. However, the central question of this paper is what is consumers' willingness to pay a premium price for several environmental attributes of organic tomato to increase both producer production and consumer health in Palestine?

Overall and specific objectives

The primary goal of the research was to investigate the potential of organic tomatoes to increase both producer production and consumer health in Palestine. In this paper we (1) estimate the effect of product attributes on households' choice; (2) estimate the households' WTP for organic tomatoes, and (3) investigate the impact of income and other socioeconomic variables on the choice of organic versus conventional tomatoes. Toward this end, the primary method of analysis in this study will be the choice experiment method.

LITERATURE REVIEW

West et al. (2002) used stated choice experiments to estimate WTP for different types of functional foods (for example anti-cancer tomato sauce), produced by conventional, organic, and GM technology. A Mixed Logit

(ML) model was used for analysis. The main results revealed that respondents were willing to pay a price premium for functional foods. Consumers were less receptive to a functional property if the functional food was a meat product. The results also indicated that many Canadian consumers would avoid GM foods regardless of the presence of functional health properties, and they are likely to accept conventional and organic functional foods if the prices are reasonable.

Probst et al. (2012) used a choice experiment to identify the marketing potential of organic vegetables in the food vending sector of Cotonou (Benin), Accra (Ghana) and Ouagadougou (Burkina Faso). Certified organic production and marketing were examined as a potential strategy to improve chemical food safety. Awareness of chemical contamination risks was generally low. The appearance of a product was central to vendor choice; consumers attributed similar utility to taste and organic certification. Consumer WTP was calculated to be a premium of 1.04 USD (per plate) if the food served contained only certified organic vegetables.

Another example of the application of this method is the paper by Quagrainie et al. (1998). A stated preference experiment was administered in major cities in western Canada in 1996 via a mail survey; there were 530 respondents. The research question dealt with how product origin, packaging, and selected demographics affect consumers' choice of red meats. Several attributes were selected for each different fresh meat product, including price, product origin, and packaging. A Nested Logit model was used to analyze the stated preference data. The results indicated that the consumers generally preferred Alberta fresh beef rather than a more general Canadian origin, but the consumers were indifferent between fresh pork from Alberta and elsewhere in Canada. Consumers' age, household income, and family size were found to affect meat choice.

Lusk and Parker (2009) applied a choice-based conjoint experiment to examine consumer preferences for the amount and type of fat in ground beef. This paper linked consumers beef choices to their health concerns and fat content. The goal of this study was to examine preferences for a heart-healthy beef product. WTP estimates showed that consumers placed significant value on beef enhanced with Omega-3 fatty acids, ranging from $1.30 to $2.21 per pound of ground beef depending on total fat content. The authors suggested that it might be profitable for the beef industry to market and sell products that are healthier for the consumer (heart-healthy beef).

Woods and Bastin (2009) used the choice experiment method to study consumers' acceptance and willingness to pay for blueberry products with nonconventional attributes: organic, Kentucky-grown and sugar-free. An in-store intercept survey was conducted in Kentucky with a sample of 557 respondents in 2007. The results found

strong evidence that demographic variables had a significant impact on consumers' preferences. For example, consumers of different ages, household income and years of education have different preferences depending on their characteristics, consumers' preferences and willingness to pay to differ for various attributes. For example, younger and mid-aged consumers with low to moderate income valued the attribute Kentucky-grown much higher than the organic feature for a pure blueberry jam product. Hovde et al. (2007) use a choice experiment to identify market preferences for high selenium beef in the United States. The survey design included three attributes: price premium, health claims, and origin. Health claims levels included the Food Drug Administration (FDA) level A and FDA level C claims. A Multinomial Logit Model was estimated. Unexpected results showed that respondents did not prefer the high-selenium beef products with the FDA level A and C health claims. The authors explained that because the words cancer and selenium were included in the claims; both words might have elicited negative perceptions about the product. Also, consumers were unfamiliar with the function of the new functional ingredient, selenium, which might reduce the risk of certain cancers. One interesting finding was that those with less health-oriented lifestyles, including those who did not exercise and who use tobacco, preferred high-selenium beef with health claims.

METHODOLOGY AND ECONOMETRIC MODELS

A choice experiment explores how consumers value and make trade-offs among the selected attributes. The selected attributes need to accurately reflect the competitive environment of the available alternatives and be strictly relevant to consumers' decision making (Blamey et al., 2001).

The primary purpose of this section is to outline a theoretical background of research methodology, where the theoretical definitions of willingness to pay concepts are discussed. Also, the choice experiment approach widely used as an empirical methodology in the economics literature (Probst et al., 2012; West et al., 2002; Quagrainie et al., 1998; Larue et al., 2004; Lusk and Parker 2009; Hu et al., 2009; Hovde et al., 2007, Hensher et al., 2005; Adamowicz et al., 1998; and Veeman and Adamowicz, 2004) is presented. For a consumer's choice problem, the classic random utility approach of consumer theory is appropriate (Manski, 1977). The choice experiment method is consistent with the Random Utility Theory (RUT). It is a data generation approach which depends on the design of choice tasks to show factors influencing choices and to understand how respondents make choice decisions (Louviere et al., 2000). A choice experiment is used to observe the effects upon one variable, a response variable, given the manipulation of the levels of one or more other variables in the choice sets (Hensher et al., 2005). The choice set is a subset of all alternatives in a universal set that are available at the time of the choice and have a non-zero probability of being chosen (Adamowicz et al., 1998).

To conduct the choice experiment, the first step is to define the study problem by asking the question: what does the study hope to achieve? After understanding the problem, the researcher must identify a list of alternatives, attributes and attribute levels which are

appropriate for the choice experiment. This step is called stimulation refinements, which means brainstorming and then narrowing the range of alternatives to consider in the experiment (Hensher et al., 2005). The critical issues in designing a choice experiment method include selecting the attributes and level of attributes, the experimental design and the treatment of the no-choice option.

A number of discrete choice models are available and differ in the assumptions made about the distribution of the error term (Train, 2009). For example, the conditional logit models error term is assumed to have a type-I extreme value distribution. The typical conditional logit model is visible as well:

1) The estimated coefficients of the attributes are fixed to be the mean values of all respondents' responses. This ignores the variation of the estimated coefficients and cannot handle preference heterogeneity among consumers. Consumer heterogeneity is an essential issue in food markets, especially when dealing with differentiated products, such as organic fruits, where target consumer preferences might be entirely different from other consumers.
2) The second major limitation of the CL model is the independence of irrelevant alternatives (IIA), also known as binary independence as an axiom of decision theory and various social sciences. The IIA property assumes that the ratio of the probability for any two alternatives is utterly independent of the existence and attributes of any other alternatives (Ben-Akiva and Lerman, 1985). It assumes that the errors are independently distributed across alternatives even for repeated choices, which is unrealistic. The CL model cannot avoid the restrictive substitution pattern of the IIA property (Louviere et al., 2000).

The Mixed Logit model is very flexible and can approximate any random utility model (McFadden and Train, 2000). The Mixed Logit model was developed by Boyd and Mellman (1980) and Bhat (1998) and Train (1998), to identify a broad range of consumers 'preference heterogeneity. The Mixed Logit probabilities are the integrals of standard logit probabilities over a density of parameters (Train, 2009). The ML model assumes that rather than being fixed, the parameters of attributes follow certain specific distributions across the respondents in the sample. Specifically, the choice probability of the Mixed Logit model of individual i choosing alternative j can be expressed as:

$$\breve{P}_{ij} = \int P_{ij} \ f\left(\beta \mid \theta\right)d$$

(1)

Where, θ = the distribution parameters of coefficient β (such as the mean and covariance of β), P_{ij} = the standard logit probability function.

The likelihood function of the ML model cannot be efficiently estimated with Maximum Likelihood estimation (Veeman and Adamowicz, 2004). However, the probability function P_{ij} in equation (7) can be estimated by a simulation method over the density function $f\left(\beta \mid \theta\right)$.

According to Train (2009), the procedure for the simulation method includes three steps. For any given value of **θ**: (1) draw a value of β from the density function $f\left(\beta \mid \theta\right)$, and name it βr with the superscript r = 1 to represent the first draw; (2) calculate the $f\left(\beta \mid \theta\right)$ found in equation 6 with the logit formula for the first draw; (3) repeat steps 1 and 2 many times (usually more than 100 times), and average the results. The average simulated probability can be expressed as:

$$\breve{P}_{ij} = \frac{1}{r}\sum_{r=1}^{r} P_{ij}\left(\beta^{r}\right)$$

(2)

Where, R = the number of draws, $\breve{P}_{ij}$= unbiased estimator and its variance decreases as R increases, the summation of $\breve{P}_{ij}$ is equal to 1 over alternatives.

The simulated log-likelihood function is given by inserting the simulated probabilities into the log-likelihood function as in the following equation:

$$SLL = \sum_{i=1}^{I}\sum_{j=1}^{J} d_{ij}\ln \breve{P}_{ij}$$

(3)

Where, dij is an indicator such that dij =1 if individual i chose alternative j, and zero otherwise and the maximum simulated likelihood estimation (MSLE) is derived by maximizing SLL over the value of the parameters of the distribution of θ (Train, 2009).

Participants

Stratified random sampling aims to produce a sample that reflects the population regarding each member of the population has an equal chance of being included in the sample and has relative proportions of people in different categories, such as gender, ethnicity, age groups, demographic groups, and region of residence.

Using a 5% margin of error, the appropriate households sample size for the Ramallah and Bethlehem governorates was 384 persons. The governorate of Ramallah and Al-Bira chose a stratified random sample, and Bethlehem governorates to identify and divide the households into two main zones with three main sub-groups. Specifically, the two governorates were broken down into three divisions and a representative sample of each stratum was selected: Division (A) household heads who live in cities (urban respondents); Division (B) household heads of rural areas (rural respondents); and Division (C) household heads who live in the refugee camps of the selected governorates.

After dividing the study population into the appropriate regions, a stratified random sample was undertaken throughout each region. The tables below clarify how we selected the sample in term of two-step samples with a stratified random technique. Villages were divided regarding population size, and we selected the largest ten villages in Ramallah and Al-Bira, and Bethlehem governorates.

Ethical approval

All procedures performed in studies involving human participants were by the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Survey and data collection

The choice experiment was administrated through an in-person survey. The survey contained seven sections. The first section asked some questions about the respondent to ensure that the household bought tomatoes from the Ramallah or Bethlehem governorates. The second section provides information to the respondents about the health benefits of organic tomatoes. The third section asked about health and environmental problems facing households in the West Bank. The fourth section gathered information about consumers eating habits and buying behaviour. The fifth section asked about household attitudes toward conventional agriculture and organic tomatoes. The sixth asked respondents to complete a series of choice tasks, which was the primary source of choice data for the estimation models in the study. The final section of the survey contained some socio-

economic and demographic questions.

Before conducting the in-person survey a pilot study, a pilot survey was carried out by different respondents from different locations in the West Bank: Al-Quds University, tomato markets in Bethlehem, tomato markets in Ramallah. Twenty respondents completed a pilot survey. This pilot study provided helpful feedback in finalizing the survey instrument and the main attributes to use in the actual choice experiments. Pilot interviews provided a good background on organic agriculture in the West Bank and how such products can give the farmers opportunities to achieve a higher profit. Accordingly, the formal survey was applied to respondents recruited from the West Bank (Ramallah and Al-Bireh governorate, and Bethlehem governorate). A random sample was taken from the two governorates, and in-person interviews were used. A survey of 345 households was taken for the whole sample.

The study site

The study is applied for two of the West Bank governorates; Ramallah and Al-Bireh governorate and Bethlehem governorate. These were chosen over other Palestinian governorates because these are the regions in Palestine most likely to be interested in organic food due to income, education, and other demographic and socioeconomic factors. This was clear from the pilot survey. Studying both Ramallah and Bethlehem increases the variance of social and economic background factors, such as nutritional habits, and governmental policies and regulations will make WTP estimates more robust.

The Ramallah and Al-Bireh governorate is located in the middle of the West Bank with an estimated population of 279,730 with 52,834 households. This governorate contains two main cities, Ramallah and Al-Bira, with a further 71 villages, and five refugee camps (Palestinian Central Bureau of Statistics, 2012). Regarding Bethlehem governorate, it is located in the south of the West Bank with an estimated population of 199,463 and with 32,667 households. This governorate contains three main cities: Bethlehem, BeitJala and Beit-Sahour, with a further 38 villages, and three refugee camps (PCBS, 2013). Accordingly, a two-step stratified random sample is adopted in this study with a population that includes urban, rural, and refugee camps.

Choice experiment

The research questions of this study focus on awareness of the importance of ensuring / securing the environment. How many households in the West Bank purchase organic tomatoes, reasons for which households may be willing or not willing to pay more for organic tomatoes, and the main socio-economic variables that affect the households willingness to pay for organic tomatoes when making organic tomatoes choices. Moreover, thus, price per kg, levels of minerals and vitamins, taste, shape, texture and how and where tomatoes where grown were selected as the main attributes for inclusion in the choice experiment.

Illichmann and Abdulai (2013) use a choice experiment approach to investigate consumers' preferences and WTP for organic food products. They apply mixed logit and latent class models to investigate preference heterogeneity of organic food products. The main result revealed significant heterogeneity in preferences for organic apples, milk, and beef product attributes among consumers.

A functional experimental design is used to maximize the information collected from the stated preference choice experiment. The objective of using fractional factorial design is to create efficient choice sets, including how to combine attribute levels into product profiles and how to put profiles into choice sets (Louviere et al., 1998).

Theoretical background

According to Train (2009), an individual i receives utility U when choosing an alternative j with a group of attributes Xij from a choice set. The utility is usually modelled with two components: an observed deterministic component Vij and an unobserved stochastic component ε_{ij} of the utility function. The utility received from alternative j is represented by:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{4}$$

Where, $V_{ij} = f(X_{ij})$, the deterministic component, is a function of the attributes of the alternatives. In the choice model, individual I faces a choice of one alternative from a limited choice set C. The probability P_{ij} that alternative j will equal the probability that the utility gained from this choice is no less than the utility of choosing another alternative in the finite choice set. The probability of individual i choosing alternative j is expressed as:

$$P_{ij} = \text{Prob} \{V_{ij} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ij}; \text{ for } j \neq k, \text{ and } k \in C\} \tag{5}$$

Attributes and levels

Given this, the base model above identifies the utility function with the main effect variables in the choice experiment. As specified before, seven attributes are included in this choice experiment, which are price, level of minerals and vitamins, taste, nutrition, shape, texture and whether the tomatoes were certified organic. These attributes include different levels which are all dummy-coded, and they become the main variables to test the effects of each attribute in the random utility function. However, the seven attributes are separated into two dummy variables equal to 0 if the household selects conventional tomatoes and one if the household selects organic tomatoes, otherwise equal to 0 (Non-purchase option). The model also contains some socioeconomic variables including income (Table 1).

This study focuses on the households' health and taste related to the choice of organically grown tomatoes, so the tested product should contain the main attributes such as taste and nutrition of organic products (Annunziata and Vecchio, 2016).

In this study, the organic tomatoes have two levels for each attribute. The attribute level of each attribute is as follows: the price of organic tomatoes are double compared with the price of conventional one, contain a higher level of minerals and vitamins are more tasty, more nutritious, less perfect-looking, the texture is matt, and are certified organic. Conventional tomatoes have seven attributes tomatoes with two levels each: the price of conventional tomatoes compared with the price of organic tomatoes, a lower level of minerals and vitamins, less tasty, less nutritious, perfect-looking, the texture is smooth and not organically certified.

The main effect is the independent effect of a particular treatment on the dependent variable, the choice. The measurement of the main effect is by the estimated parameter of that treatment variable. An interaction effect is the combined effect of two or more treatments upon the dependent variable. The interaction effect could be measured by the estimated parameter of the combined variables. The main effects and interaction effects determine the degrees of freedom of the experiment, which is directly related to the design of the minimum number of profiles. The number of profiles needs to be sufficient to estimate both the main effects and

Table 1. Attributes and Levels in Choice Experiment.

Attributes	(Organic fruits or vegetable)	(Conventional fruits or vegetable)	Non-purchase option
Price per Kg	3 NIS	1.5 NIS	I Do not Know
Please choose one of these choices.	☐	☐	☐
Levels of minerals and vitamins	Contain higher level	Contain lowe level	I Do not Know
Please choose one of these choices.	☐	☐	☐
Tasty	Very Tasty	Tasteless	I Do not Know
Please choose one of these choices.	☐	☐	☐
Nutritious	Nutritious	Less nutritious	I Do not Know
Please choose one of these choices.	☐	☐	☐
Shape	Less perfect looking	Perfect looking	I Do not Know
Please choose one of these choices.	☐	☐	☐
Texture	Matt	Smooth	I Do not Know
Please choose one of these choices.	☐	☐	☐
How tomato where grown	Certified Organic	Not Organic	I Do not Know
Please choose one of these choices.	☐	☐	☐

interaction effects.

Model specification and statistical analysis

In the course of this paper, consumer i faces the choice of one alternative among organic tomatoes, regular tomatoes and the no purchase option, given various attribute level combinations in each choice set. The probability of consumer i choosing alternative j equal the probability that the utility received from alternative j is greater or equal to the utility when choosing conventional tomatoes or not making a purchase.

McFadden (1974) developed the conditional logit model to estimate these probabilities assuming the stochastic error term is independent and follows a Type-I extreme value distribution. Assume the observed deterministic component V_{ij} is a linear function of perceived product attributes X_j, so $V_{ij} = \beta X_j$. The choice probability of consumer i choosing alternative j in the conditional logit model is formed as:

$$U_{ij} = X_{ij}\beta + e_j \tag{6}$$

Where, ß is a vector of estimated parameters, X_{ij} represents a vector of the selected attribute levels in the choice set, e_j is the error term associated with the utility brought by alternative j, which cannot be captured by the attributes.

Given the specified attributes and levels of organic tomatoes and vegetables in this study, a linear indirect utility function of consumer i choosing alternative j in one choice set is specified as:

$$U_{ij} = \beta_1 (NoPurchase\ Option) + e_j \quad where\ j = (no\ purchase)$$

$$U_{ij} = (1 - No\ Purchase) * (\beta_1 Price_j + \beta_2 LevelsOfMineralsAndVitamins_j + \beta_3 Taste_j + \beta_4 Nutrition_j + \beta_5 Shape_j + \beta_6 Texture_j + \beta_7\ TomatoesCertifiedOrganic_j) + \alpha_1\ Income_i + \alpha_2\ Education_i + \alpha_3\ FamilySize_i + \alpha_4\ Employment_i + e_j\ (j \neq no\ purchase)$$

$$\tag{7}$$

Willingness-to-pay

Willingness-to-pay is the amount of money a person is willing to pay to get or avoid something other than the status quo. The aggregation of all stakeholders' willingness-to-pay is what is sought in identifying the net benefits of a policy. If someone was made worse off as a result of the change, we could introduce the notion of compensation to bring them back to at least the same level of well-being even if others' well-being was improved. If, after performing the analysis, there are any estimated net benefits, this would imply that the proposed change would be a Pareto improvement over the status quo.

With a linear random utility function, the marginal utility of income is independent of income and prices, and that income effect is negligible, i.e., the compensated (Hicksian) demand curve and the Marshallian demand curve approximate each other, (Small and Rosen 1981) as shown in Figure 1. If this were the case, the price of tomatoes would appear in equation 3, but income would not.

Willingness-To-Pay (WTP) is often adopted by researchers to jointly interpret the estimated parameters and identify the money values associated with changes in each attribute. The marginal WTP indicates the maximum amount that the respondent would be willing to pay in order to receive/avoid a particular attribute of the product (Burton et al., 2001). The marginal WTP can be derived from equation three as follows:

Total WTP = Consumer surplus + market price

Average WTP (Consumer surplus)

Market demand curve
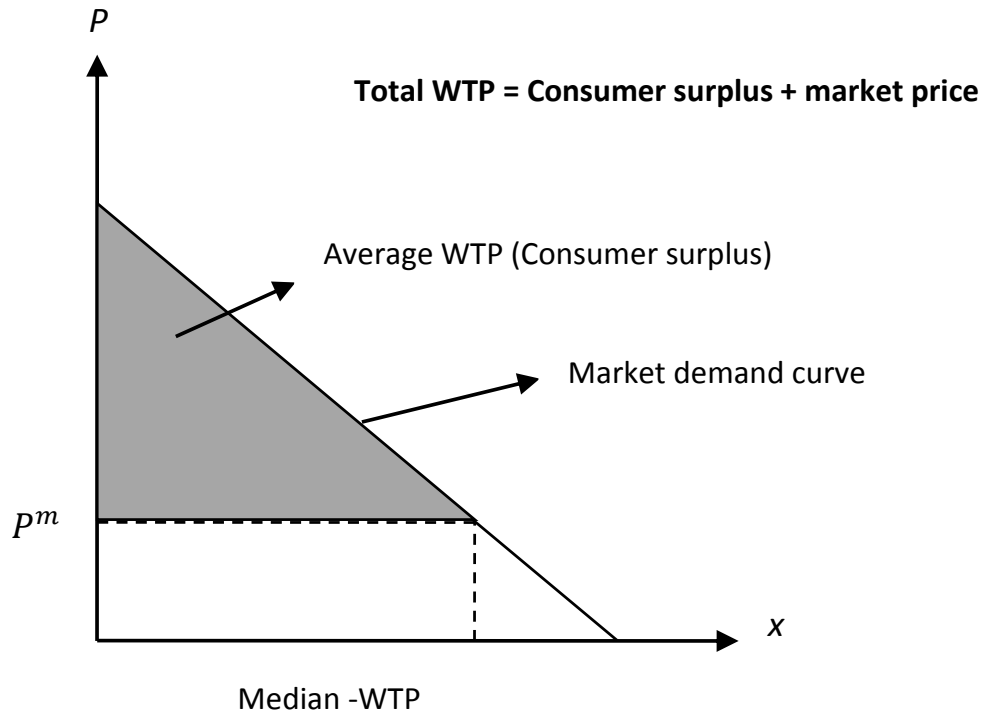
Figure 1. Marshallian demand curve, consumer surplus and WTP.

$$WTP_{x_k} = \frac{\beta_k}{\beta_{price}}$$

(8)

Where, β_k is the estimated parameter of the attribute x_k moreover, $\beta price$ is the parameter for the price, WTP_{x_k} represents the money value that respondents are willing to pay for the attribute x_k of the product characteristics.

Some studies (Ryan and Huges, 1997; Ryan, 1999; Peracchi F, 2001; Lee, 2002; Johnson et al., 2000) have also calculated the WTP arising from a change in all levels of a product as follows:

$$WTPmedian = \sum \frac{\beta_k}{\beta_{price}}$$

(9)

Because of its simplicity, median willingness to pay is a popular measure of central tendency for the probit/logit model. Also, the median willingness to pay appears to be less sensitive to distributional misspecification in a referendum framework.

Substitutions of the model

Equations 10 and 11 represent the functional relationship among variables adopted in this study.

$U_{ij} = \beta_0$ (Nopurchase option) $+ \varepsilon$, *where j = No purchase*
$U_{ij} = (1-$ No purchase$) * (\beta_1$ Price$_j$ + β_2 Levels of Nutritional Uncertainty$_j$ + β_3 Taste$_j$ + β_4 Nutrition$_j$ + β_5 Shape$_j$ + β_6 Texture$_j$ + β_7 Certifies Organic$_j$) $+ \varepsilon$, (10)

Where, j = No purchase

$$U_{ij} = X_{ij}\theta + u_j$$

(11)

Where, θ is a vector of estimated parameters, Xij represents a vector of the selected attribute levels in the choice set and uj is the error term associated with the utility brought by alternative j, which cannot be captured by the attributes.

EMPIRICAL FINDINGS

Variables of the estimation models

This section presents estimation results for the utility models developed to answer the following research questions and hypotheses; (1) Palestinian households pay a premium for organic tomatoes; (2) Palestinian households are willing to pay for organic tomatoes and (3) Palestinians household socio-economic variables have a significant effect on WTP for environmentally green products of organic tomatoes. The choice models examine the responses of consumers in term of the health claim, attitudes and income level. Also, the models used in this study are: (1) the Mixed Logit model and Willingness-To-Pay (WTP) for random parameters; (2) the Mixed Logit model with interaction effects between main variables for fixed parameters. However, Table 2 shows the Variables used for the Estimation Models.

Table 2. Summary of the variables for the estimation models.

Attributes	Abbreviation	Description
Price	x1	The price adopted in the choice experiment for a kg of organic and conventional tomatoes. Also, the household must pay double for organic tomatoes.
Nutritious	x4	One if the tomatoes are organic, otherwise 0.
Shape	x5	One if the tomatoes are organic, otherwise 0.
Educational level	x11	The level of education of Palestinian households in the West bank are classified into four main categories: 1) Completed primary school or less 2) Completed diploma degree 3) Completed bachelor degree 4) Completed master degree or higher
Monthly income	x12	The level of income for the Palestinian households in the West Bank. **Note**: the —Income‖ variable is measured by the value of New Israeli Shekel (NIS) in all estimation results.
Family size	x13	The household family size of Palestinian households in the West Bank.
Employment status	x14	The Employment status of Palestinian households in the West Bank. One if the household works, otherwise 0.

Table 3. Basic tomato model: ML Estimations and WTP.

Variables	Coefficients	Standard Error	Z-value	P>|z|	[95% Conf. Interval] Lower	Upper
Price	0.6764433	0.0299105	22.62	0.000	0.6178197	0.7350668
Nutritious	0.2349293	0.0408706	5.75	0.000	0.1548245	0.3150341
Shape	0.127888	0.0270699	4.72	0.000	0.0748319	0.1809441
Constant	0.0133135	0.0343863	0.39	0.699	-0.0540824	0.0807093
Log-likelihood		41.465059				
Pseudo-R^2		0.187478				
Median WTP		0.53636 (NIS)				

Respondents' willingness to pay

The study results show that about 33% of respondents are willing to pay a premium price for organic tomatoes. This result is relatively acceptable compared with Marangona et al. (2016) who revealed that only 8% of respondents are willing to pay a premium price for vegan breadsticks and that there is the opportunity to develop local chains for vegan niche markets (Engjell et al., 2017).

Tomato Model (ML) estimates and willingness to pay

Tomato model contains the effects of the main attributes in the choice experiment measured on it, including the price, nutrition, and shape of a tomato. However, Table 3 shows the CL and WTP results for the tomato model. The value of the Log Likelihood Function is 41.465059, and the Pseudo-R^2 is 0.187, indicating that the goodness or fitness of this model is moderately good (Train, 2009). All

coefficients are statistically significant at the 5% level, the household's willingness to pay 0.54 (NIS) for organic tomato.

According to the estimation results in Table 3, consumers are more likely to prefer organic tomatoes. Palestinian consumers might believe that organic tomatoes are better for health and environment than conventional tomatoes based on Table 4, 46 discussed in the previous section. Palestinian consumers can pay 0.53 for organic tomato more than conventional tomatoes; they believe that the organic tomatoes are more nutritious than conventional tomatoes and the less perfect shape of organic tomatoes does not be an obstacle to pay for organic tomatoes.

Tomato Model (ML) estimates and WTP interaction effects

Table 4 shows a basic model for all random affects

Table 4. Tomato ML Estimations and WTP with interaction effects.

Variables	Coefficients	Standard Error	Z-value	P>|z|	[95% Conf. Interval] Lower	Upper
Educational level	0.0201369	0.0269285	0.75	0.455	-0.032642	0.0729157
Monthly income	0.000031	0.0000145	2.14	0.032	2.65e-06	0.0000594
Family size	0-.012092	0.0121056	-1.00	0.318	-0.0358185	0.0116345
Employment status	-0.0246058	0.0733299	-0.34	0.737	-0.1683298	0.1191181
Constant	0.6066177	0.1139031	5.33	0.000	0.3833718	0.8298636
Log-likelihood		-212.27546				
Pseudo-R^2		0.017356				

variables that urge Palestinian consumers to WTP organic tomatoes. The estimation results in Table 4show the interaction effects for the main socioeconomic and demographic variables in the choice experiment.

According to Table 4, all interaction variables are not significant except that the income level was significant at the 5% level, indicating that Palestinian consumers educational level, family size, and employment status do not play a role when the purchase option of organic tomato has been made. Also, the main decisive factor affecting the consumer purchasing option is the income level of this consumer.

DISCUSSION

In Palestine, this study is, to the best of my knowledge, the only one that has used CEM by using econometric analysis to accomplish its objectives. The overall objective of this study is to develop policy background information on the demand for organic tomato. The goodness or fitness of the study model is moderately good (Train, 2009), so that It is argued that consumers 'growing interest in organic foods provides value-added growth opportunities to the Palestinian agricultural sector (Agriculture and Agri-Food Canada, 2009). Consumers' response to organic tomato is a relatively new research area with many unanswered questions regarding the household's awareness of this kind of food. Given the nature of organic tomato, nutrition and taste of it play a primary role in helping consumers making consumption choices. This study has examined the household WTP of tomato through an analysis of consumers 'stated preferences for specific characteristics', which is likely to be consistent with the results in other previous research (Marangona et al., 2016). Also, some other potential influences on consumers 'decisions were considered, such as attitudes towards organic tomato, consumers' health status and knowledge, trust in organic food benefits and socio-demographic variables affect the purchasing decision Skreli et al. (2017). However, the empirical evidence of this study is to introduce solutions and scenarios that may be of exceptional and great value to researchers and decision makers.

Conclusions

The growing market around the world for organic foods, especially tomato products, provides a potential opportunity to improve health and environmental saving of Palestinians and enable the development of a new value-added food sector. With the growing interest among consumers in the relation between the green environment and health, and the knowledge of the attributes benefits in organic food products is likely to play a critical role in consumers' choices. The results estimated in this study have answered the research questions related to the demand for organic tomatoes as described. However, ML is a discrete choice model based on random utility theory.

As discussed before, we indicate that consumers' growing interest in organic tomatoes provides value-added growth opportunities to the Palestinians agricultural sector. Given the credence nature of organic tomatoes, price, nutrition and the shape of them play a crucial role in helping consumers make consumption choices.

Households spend about 10% of their monthly income, which is about 4170 (NIS), on conventional fruits and vegetables without knowing the ultimate effects of them compared to the benefits of organic products. At the same time, households are willing to pay 0.54 (NIS) as a premium for organic tomatoes over the conventional ones when knowing the ultimate benefits of the organic products in the West Bank.

Information asymmetry of respondents can appear if they are uncertain about the validity of the health claim so that public policymakers should be aware that the verification of health claims plays a vital role in reducing households' uncertainty and making health claims more credible.

The government is advised to (1) increase the income

level of Palestinian households. If not, the government should cover the difference in prices between organic and conventional tomatoes of producers; (2) label the organic product in terms of the quality perception of consumption is significantly essential, which is likely to consistent with other previous research (Thai and Pensupar, 2015); and (3) provide organic tomatoes all the year round.

Limitations

This article focuses on examining the Palestinian households WTP of tomato in West Bank through using the choices experiment methodology of research. One limitation of this study is associated with the hypothetical nature of the stated preference approach since respondents are asked to state their preference values, but actual choice behaviour may differ. Consumers may provide silly statements if there is no cost to over (or under-) stating their willingness to pay. Estimation bias may be present due to strategic behaviour by respondents, especially when consumers are unfamiliar with the product (for example a food product with a new functional attribute), their stated willingness to pay may be inaccurate. However, other methods, such as experimental auctions, have been widely discussed in the literature associated with economic evaluation methods and could be used in future research on this topic. As discussed by Hu et al. (2006), it is broadly believed that the use of experimental auctions in consumer research can capture the real willingness to accept a product and reduce the bias caused by strategic behaviour. However, the costs of conducting auctions on representative samples are usually relatively higher than the Stated Preference Method, and as a result, sample sizes tend to be smaller. Thus, another limitation of this study only two organic vegetables and one organic fruit were investigated due to time and budget constraints. Future studies should consider the WTP for other organic products. Also, Ramallah and Bethlehem governorates were examined, future studies should be replicated for other governorates in the country to determine the overall market size and consumers WTP for organic fruits and vegetables. However, some of the Variables tested in the WTP model were not statistically significant probably due to the sample size. To address the statistical limitation, future studies should consider a large sample size in order to increase the degree of freedom. Future research should focus on the cost-benefit analysis of organic farming so that the financial viability of organic farming in Palestine based on percentage willingness to pay could be explored.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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The mobility of intergenerational income for rural residents: The case of China

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Based on the data of China Health and Nutrition Survey (CHNS) from 1989 to 2015, this paper analyzes the mobility and transmission mechanism of rural residents' intergenerational income. The OLS estimation of father and son yields a value of 0.549. The results of quantile regressions show that in rural China, the intergenerational income elasticity (IGE) is higher at the high end but lower at the low end. The human capital investment represented by the schooling years of the children is indeed an important factor explaining the intergenerational income mobility in the rural, and its contribution rate is 26.6%, much higher than the contribution of occupation. Further, the decomposition results indicate that education plays a more important role both at the low end and the high end, while occupation plays a more important role at the media quantile.

Key words: Rural resident, intergenerational income mobility, transmission mechanism.

INTRODUCTION

China's economy has been growing at a rapid speed for around forty years since the reform and opening up. These rapid economic developments have also been accompanied by dramatic social transformations; the mobility of intergenerational income has been debated more and more recently. This paper estimates the intergenerational income mobility based on a micro-income dataset which spans 26-years from 1989 to 2015, and further analyses the mobility mechanism of the intergenerational income for Chinese rural residents.

Intergenerational income mobility is the extent to which parents' income affects the income of their children. Becker and Tomes (1979) first put forward the theoretical framework of the intergenerational income mobility from

the economic perspective. In this framework, intergenerational income mobility is generally expressed in terms of generational income elasticity. The higher the elasticity is, the greater the impact of parents' income on the income of children is, indicating lower intergenerational income mobility. The intergenerational income elasticity (hereinafter IGE) in the United States is around 0.2 (estimated by Behrman and Taubman (1985) and Becker and Tomes (1979), indicating that intergenerational income liquidity is high in United States. However, these results were biased because the estimates of the intergenerational elasticity in previous studies tended to use earnings in one year for both fathers and children. Toward this, subsequent studies

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continue to improve the relevant theories (Solon, 1992; Haider and Solon, 2006; Bohlmark and Lindquist, 2006). There are many literatures that examine the degree of intergenerational income mobility in developed countries (Lee and Solon, 2009; Lefgren et al., 2012; Lefranc et al., 2014; Palomino et al., 2018).

However, the existing literature seldom focuses on developing countries, more discussions are necessary for the case of developing countries. As the world's most populous nation, Chinese living standards have risen since 1979. These rapid economic changes have also been accompanied by dramatic social transformations. All this makes China a unique case study through which to better understand the relationship between societal change and income mobility.

For the case of China, Zhang and Eriksson (2010) estimated the relationship between the parents' income and the children's individual income in the same household using the CHNS data (1989 - 2006), and concluded that the generational income elasticity is about 0.45. Deng et al. (2013) have found that the intergenerational income elasticity of sons to fathers in 2002 is 0.53 and in 1995 is 0.47 when an accounting period of three years is applied. In a more recent work by Li et al. (2014) adopted the data from CHNS spanning from 1989 to 2009 to do the Instrument Variable (IV) estimation, and the finding revealed that the intergenerational correlation in terms of the long-run income is 0.83 in China. Based on the 1995 and 2002 waves of CHIP, Fan (2016) found that the estimated intergenerational income elasticity is 0.43 and 0.51 for cohorts educated prior to and after the market reform, respectively. Moreover, the intergenerational income elasticity for the urban households whose income is above average in the post-reform China reaches 0.71. All of the papers earlier mentioned have shown that intergenerational income mobility is low when intergenerational income elasticity is higher than 0.4.

Estimating intergenerational income elasticity is the most basic step in the study of intergenerational income mobility. What is even more remarkable is the mechanism by which the parents' income is passed to the children. In some empirical studies, the data of communities, siblings, twins, and adopters are used to study the roles of the congenital endowment and acquired environment in the mobility of intergenerational income (Mazumder and Fortunate, 2005). Almost all of these studies show that the genetic endowment has a great impact on the intergenerational income mobility, accounting for about 50% of the total contribution. For the impact of human capital, scholars mainly studied the role of education in intergenerational income flow. Gong et al. (2012) found that education, especially tertiary education, is an important channel through which earning ability is transmitted from parents to their children in urban China. With a simultaneous equations model, Qin et al. (2016) found that both education and health, especially education, play an important role in intergenerational transmission. In addition, due to the lack of sound labor market in China, the parents with high income will not only invest in human capital but beyond that, they will try their best to seek a good job for their children through their own social networks and personal connections. In general, the social capital of the parents influences the children's occupation mainly through three aspects: career transmission, social network and power rent-seeking; and indeed affect the income level of the children. Fan (2016) explored three channels of intergenerational income transmission: education, social capital and own ship of work unit, and declared that in the post-reform era, parents from various income groups invest in children's intermediating variables which generate statistically significant and high return: schooling for the lower 50% families and social capital for the upper 50% households.

Because of the household registration system, China has formed the urban-rural dual economic structure; most existing studies are confined to the study of the intergenerational income mobility of urban residents. But in fact the rural economy is a critical component of Chinese economy, as the reform in the countryside is the starting point of China's reform and opening up. Because of the importance and distinctiveness of rural development, it is meaningful and necessary to study the intergenerational income mobility of rural residents.

Generally, this paper will mainly estimate the intergenerational income mobility of rural residents, and discuss the micro-mechanism of intergenerational income transmission from the perspectives of education and occupation. In contrast to the previous researches, the main contributions of this paper are as follows: First, most of the previous studies about intergenerational income in China focused on the urban area, few of them concerned about the rural area. On the contrary, this study uses the latest data with a long time span at the micro-level, thus we can examine the intergenerational income elasticity for the rural residents in a clearer manner. Second, more and more studies begin to focus on the nonlinear characteristics of the intergenerational income mobility (Chen et al., 2017; Palomino et al., 2018); this latest research trend was followed to adopt the method of Quantile Regression (hereinafter QR) to examine the intergenerational income mobility of rural residents at different quantiles. Beyond that, the mobility mechanism of the intergenerational income was also compared at different quantiles.

METHODOLOGY

The model

Based on previous studies (Becker and Tomes, 1979; Solon, 1992), the basic equation of intergenerational income elasticity in this paper is specified as follow:

$$Lny_i^s = \alpha_0 + \rho Lny_i^p + \varepsilon_i \tag{1}$$

where y_i^s is children's permanent income, and y_i^p is the permanent income of the parents. ρ represents the degree to which parents' permanent income influences their children's permanent income.

As it is difficult to obtain the reliable data of parents' permanent income, we generally use the parents' annual income as a proxy of the permanent income. However, due to the large deviation between their annual income and permanent income, using the parents' annual income to estimate the intergenerational income elasticity is likely to result in downward bias. As the entire data of all available pairwise observations of adult sons and parents' income are allowed to be used to estimate the intergenerational income elasticity and the influence of the life cycle on income of both parents and children can be controlled in the approach in Lee and Solon (2009); this methodology was used in order to solve the problem of the life cycle bias, thus the basic equation can be adjusted as follow:

$$\ln y_{it}^s = \alpha + \beta \ln y_i^p + \sum_{n=1}^4 \gamma_n A_i^n + \sum_{n=1}^4 \delta_n C_{it}^n + \sum_{n=1}^4 \theta_n [\ln y_i^p] C_{it}^n + \varepsilon_{it} \tag{2}$$

The dependent variable y_{it}^s in the intergenerational regression equations estimated is the son's log annual income in years ranging from 2000 to 2015 and at ages ranging from 20 to 49. The independent variable y_i^p is the averaged parental household income of family i when the son was a child between 10 and 17 years old. This paper mainly estimates the elasticity of intergenerational income from fathers to sons for two reasons. First, a potentially important issue is that in the baseline estimates, only members of the two generations who co-reside were observed. If the co-residing parent/child pairs are systematically different from the residing separately parent/child pairs, the estimates based on the former sample could be biased due to sample selection (Deng et al., 2013).[1] Second, generally speaking, the father holds most resources in the family and may have a greater impact on the children in rural China. Compared to men, women's market participation rate is lower and more volatile, resulting in the selection bias when women enter the labor market and large estimation bias for the intergenerational income elasticity (Gong et al., 2012).

The influence of the life cycle on parental and son's income is well controlled in Equation (2). Variable A_i^n represents the age of the parent in family when the children were 10 and 17 years old. Variable C_{it}^n is included to control the son's age. It is calculated as the difference between the son's age and the age of 40 years old at each year when income is computed, thus centering the estimates at the age of 40. If c is the birth year of the individual, t-c is the age when the income is reported, therefore C=t-c-40. Variable $[\ln y_i^p] C_{it}^n$ is the interactive term of parental income and the age of the son, which interprets the possible divergences in life-income patterns depending on parental income.[2] γ_1 to γ_4, δ_1 to δ_4, and

θ_1 to θ_4, are corresponding parameters, respectively.

Quantile regression

As discussed earlier in the model, it was confirmed that the parents' income has impact on the income of the children through OLS estimation and this impact is still valid even for the average income. However, some previous studies suggest that the intergenerational income elasticity may not be linear (Bhattacharya and Mazumder, 2011; Corak et al., 2014), that is, the intergenerational income elasticity under different income distributions may not be the same. Therefore, the method of Quantile Regression was adopted to examine the intergenerational income elasticity under different income distributions. Initially, the QR estimates are obtained for the pooled 2000-2015 sample. As Palomino et al. (2018) said, the large size of the sample allows us to obtain highly accurate QR estimates at the tails.

The OLS method assumes that the mean of the conditional distributions is a linear function of x and fits a linear equation of the desired condition. As with the OLS regression, the QR examines the conditional distribution of the dependent variable y on the basis of the given independent variable x, but the overall q quantile $(y_q(x))$ of the conditional distribution $(y|x)$ in the QR is a linear function of x, that is:

$$y_q(x_i) = x_i'\beta_q \tag{3}$$

where y is the dependent variable, which is the income of children; x_i is the independent variable vector, which is the income of parents, the age of the parents and children, and β_q is the coefficient of q quantile, and the estimator can be constructed in the following minimization issue:

$$\min \sum_{i:y_i \geq x_i'\beta_q}^n q \left| y_i - x_i'\beta_q \right| + \sum_{i:y_i < x_i'\beta_q}^n (1-q)| y_i - x_i'\beta_q|.$$

OLS minimizes squared errors and yields the estimates at the mean of the distribution. In contrast, QR minimizes absolute errors at any particular quantile of the mean of the conditional Y|X distribution (Koenker and Bassett, 1978; Koenker, 2005). In addition, Mitnik et al. (2015) suggest that the OLS estimates of elasticity using log transformed income are centered at the geometric mean instead of the arithmetic mean; but different from OLS with the mean, the median and the quantiles estimated by QR are unaffected by a log transformation.

Decomposition of intergenerational income persistence

Following the literature (Blanden et al., 2007; Fan, 2016), the Blanden decomposition method was also used, which decomposes the intergenerational income persistence through several equations. First, the Blanden decomposition method uses the

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[1] Constrained by the CHNS dataset, it is unable to launch more in-depth discussions. However, Deng et al. (2013) found that the impact of co-reside on the intergenerational income elasticity for the father-son pair is relatively less remarkable than that for the father-daughter pair, indicating the estimation bias induced by co-reside would be smaller by only using the father-son matching sample.

[2] As Lee and Solon (2009) declares, the measurement error in log current income as a proxy for log lifetime income is mean-reverting at the early stage of the life cycle, whereas mean-departing at the late stage of life cycle, as the

systematic heterogeneity across individuals in their rates of income growth in their lifetime. Generally speaking, the individuals with high lifetime income tend to have steeper income growth trajectories. To account for this pattern, both the child's age and the interaction of child's age and parental income should necessary to be controlled in our study.

following equation to derive the intergenerational income elasticity γ.

$$\ln y_{it}^s = \beta_0 + \gamma \ln y_i^p + \mu \qquad (4)$$

where y_{it}^s is the income of the children in year t and y_i^p is the parents' income when the son was a child between 10 and 17 years old. Similar to Equation 2, the age of father, the age of son, as well as the interactive term of the father's income and the age of son are controlled when Equation 4 is estimated. In the first step, the intermediate factor on the parents' income was regressed, and then in the next step we use the regress intermediate factors on the children's income as follows:

$$IN_k = \varphi_k + \lambda_k \ln y_i^p + \mu_k \qquad (5)$$

$$\ln y_{it}^s = \omega + \sum_{k=1}^2 \theta_k IN_k + v \qquad (6)$$

where IN_k represents the intermediate factor, k=1, 2, represents the education and occupation factors, respectively. In general, the more educated a person is, the more likely he/she is to have a career with a higher score. Therefore, Fan (2016) was followed to control the education variable in order to acquire the pure effect (λ_2) of the father's income on son's occupation when Equation 5 is estimated. Moreover, the same control variables are introduced into the regressions when Equations 5 and 6 are estimated

Equations 5 and 6 can be regarded as the process that the parents obtain the return from the income of children through the investment on different factors, which can be referred to as the parents' investment equation and the children's return equation. λ_k and θ_k represent the investment coefficient of the parents and the rate of return of the children, respectively. The estimated value of intergenerational income elasticity is given by:

$$\gamma = \sum_{k=1}^2 \lambda_k \theta_k + \frac{Cov(v, y_{ot})}{Var(y_{ot})}.$$

Thus, the parents' investment coefficient and the rate of return of the children determine the degree of interpretation of the intermediate factors to the intergenerational income mobility. The contribution of the intermediate variable to intergenerational income transmission is:

$$\tau_k = \frac{\lambda_k \theta_k}{\gamma}.$$

DATA

In this paper, the data is derived from China Health and Nutrition Survey (CHNS). CHNS is conducted collaboratively by the University of North Carolina (UNC) and the Institute of Nutrition and Food Safety of Chinese Center for Disease Control and Prevention (CDC). This paper adopts ten waves of CHNS, that is waves 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, 2011 and 2015. Nine representative provinces in the eastern, central and western China are mainly covered, which are Liaoning, Jiangsu, Shandong, Heilongjiang, Henan, Hubei, Hunan, Guangxi and Guizhou.

Above all, the information of the parents (father) and the children (son) are separated in the sample of rural household, then the data of the parents and children in the same family are combined together to construct a comprehensive dataset t of one-to-one correspondence between the parents and their children. The father's income from 1989, 1991 and 1993 waves are averaged to obtain the father's income when the sons are 10 to 17 years old. In view of the basic characteristics of the general labor force in rural China and in order to avoid the bias of life cycle, this paper sets the upper limit of the age of the parent labor force to be 60 years old. The observations of income in the labor market from 2000, 2004, 2006, 2009, 2011 and 2015 waves are used to calculate the son's income. In the rural area, the laborers enter the labor market at relatively young age even many of them are still underage. However, including the children too young will lead to larger measurement error of income. As a result, this paper only regards the adult (20 to 49) children as the work force. Finally, income is adjusted by the consumer price index (CPI) in 2015 derived from CHNS.[3] After further deletion of the outliers, the sample in this paper consists of 795 valid observations (pairs).

Table 1 shows the descriptive statistics of the key variables such as annual income, age, education and occupation of the children. The variable, *income*, is total net income, which mainly includes wage income, business income and agriculture-related operational income (farming income, gardening income, animal livestock income and fishing income). As the net income data are deflated by the 2015 CPI, it can be compared directly in our sample. The observations of sons' income are available since 2000, with the mean of 20113 Yuan; while the observations of fathers' income are available in 1989, 1991 and 1993, with the mean of 4654 Yuan. For *Age*, the mean for the sample of sons is 28 years and the mean for the sample of fathers is 43 years. For *Education*, the average schooling year for the sample of sons is 9 years, which indicates the rural labor at the age of 28 have received junior high school education on average. Since the reform and opening up, the rural residents can access the non-farm employment because of the rapid development of China's non-agricultural economy, thus "farmer" no longer means a profession but a status instead. *Occupation* is calculated according to Erikson and Goldthorpe's (2002) occupational classification table and the average score is 3.6.

INTERGENERATIONAL INCOME MOBILITY OF RURAL RESIDENTS

Estimation of intergenerational income elasticity

Here, the results of pooled data regression were discussed. The estimated intergenerational income elasticity (β) from the pooled (1989 - 2015) sample is displayed in Table 2. Model 1 lists the estimation result of Equations 1 and Model 2 lists the estimation result of Equation 2. As discussed earlier in the data, the fathers' income average over three years is applied as the proxy of permanent income. Without any control variables, the estimate of intergenerational income elasticity is 0.432, but it increases to 0.549 as bias is reduced since the age of father, the age of sons and the interactive term of the age of son and father's income. This result is in accordance with the theoretical prediction (Lee and Solon, 2009) and reveals that a 10% increases in fathers'

Table 1. Descriptive statistics of the key variables.

Variable	Definition	Unit	Mean	SD
Sons				
Income	Annual net income of the son	Yuan	20113.2	54266.78
Age	The age of the son	Years	28.3	5.91
Education	Individual schooling years	Years	9.2	2.74
Occupation	Be calculated according to Erikson and Goldthorpe's (2002) occupational classification table	Points	3.6	2.06
Fathers				
Income	Average net income of three years of the father when the son was a child between 10 and 17 years old	Yuan	4654.1	2908.55
Age	The age of the father when the son was a child between 10 and 17 years old	Years	43.3	5.01

Occupational classification table: *occupation*=10 if the occupation of the children is administrator, executive, manager, army officer or police officer; *occupation*=9 if the occupation of the children is senior professional or technician; *occupation*=8 if the occupation of the children is junior professional or technician; *occupation*=7 if the occupation of the children is office staff; *occupation*=6 if the occupation of the children is skilled worker; *occupation*=6 if the occupation of the children is ordinary soldier or the policeman; *occupation*=5 if the occupation of the children is service worker; *occupation*=4 if the occupation of the children is driver; *occupation*=3 if the occupation of the children is non-skilled worker; *occupation*=2 if the occupation of the children is farmer, fisherman, or hunter; *occupation*=1 if the occupation of the children is something else. In this way, discrete variables can be transformed into continuous variables.

Table 2. The intergenerational income elasticity of rural residents.

Variable	Model (1)	Model (2)
Fathers' or Parents' income (logarithm)	0.432*** (0.083)	0.549** (0.267)
Observations	765	765
R-squared	0.033	0.166

*Significant at 10%, **Significant at 5%, ***Significant at 1%. Robust standard errors is in parentheses.

Table 3. The review of the estimates of Chinese IGE in latest literature.

Variable	Elasticity			Data and Year	Source
	Total	Urban	Rural		
Father-son	-	0.468	-	UHEES (2004); UHIES (1987-2004)	Gong et al. (2012)
Father-son	-	0.491, 0.561	-	CHIP (1995, 2002)	Deng et al. (2013)
Father-son	0.442-0.615	-	-	CHNS (1989-2009)	Li et al. (2014)
Father-child	-	0.421	0.409	CHNS (1989-2009)	Qin et al. (2016)
Father-child	-	0.433, 0.512	-	CHIP (1995, 2002)	Fan (2016)

income will on average lead to a 5.49% increase in their son's income.

Table 3 reviews the estimate of the Chinese intergenerational income elasticity in the recent literature.

It can be easily found that, the estimate of

the intergenerational income elasticity from fathers to sons and intergenerational income elasticity from fathers to both sons and daughters dominate the existing research, indicating the intergenerational income elasticity from fathers to sons is higher and the elasticity will slightly decrease if the sample of daughters is also used, which is consistent with the findings in Chadwick and Solon (2002) and Raaum et al. (2007). Besides, most research aimed at the urban area so far, few of them focus on the rural area. The estimated intergenerational income elasticity in rural China is 0.409 (Qin et al., 2016), but this result may be underestimated as its sample is fathers and children (both sons and daughters), with education and health variables controlled. Finally, it is obvious that the intergenerational income elasticity in China is higher, that is, the mobility of intergenerational income is lower compared with the estimation results in other countries,[4] no matter in the urban area or the rural area.

Intergenerational income elasticity based on quantile regression

More importantly, if we extend our studies to the conditional quantile regression estimations, the intergenerational elasticity is lower at lower quantile, even negative at the bottom end of income distribution. The intergenerational income elasticity shows an upward trend as the quantile of income moves to the upper tail. The intergenerational income elasticity grows at an increasing space since the 10th percentile. Although it fluctuates at the 80th percentile, the steadily increasing trend is maintained. At the quantile higher than the 80th percentile, the intergenerational income elasticity skyrockets, even higher than 1. These results indicate that the "inheritance" of family income in rural China varies when we move along the conditional income distribution of adult sons. Children at the upper low part of the conditional distribution show the smallest degree of intergenerational persistence, while top incomes are very much conditional by their childhood economic circumstances, represented here by parental income.

Previous studies estimating the IGE at different quantiles have not yet reach a consensus. Tejada et al. (2015) estimated the intergenerational income elasticity for the 1982 born cohort in the city of Pelotas (Brasil) and found higher values of the IGE at both ends of the income distribution. In line with this study, Palomino et al. (2018) also found a U-shaped relationship in the United States. On the other hand, if we measure intergenerational

elasticity for child and parents labor earnings, there will be another result. For example, Bratberg et al. (2007) apply QR for earnings data from Norway cohorts born in 1950 to 1960, and find the decreasing relationship between the IGE and the position at the income distribution with higher IGE at the bottom tail, but more mobility (lower IGE) at the upper tail of the income distribution. Using a sample of 1424 observations, Cooper (2011) found a continuous decrease in the IGE as we go up the income distribution. As Palomino et al. (2018) declared, valuing the intergenerational elasticity of sons' income would lead to underestimation of the actual IGE at the top quantiles, a possible cause is a great deal of the correlation between parental and children incomes at the upper part of the distribution could occur through capital income, which is counted in the total household income variable.

In the present paper, the father's total income and the son's total income are applied. No matter in Tejada et al. (2005) and Palomino et al. (2008) or in the present study, the similarity lies in the fact that the intergenerational income elasticity increases as the quantile moves to the top quantiles. The remarkable finding in the present paper is that the intergenerational income elasticity verified is lower at bottom quantiles, especially in rural China. The implications of this funding are as follows: (1) At bottom quantiles, if a father belongs to the low-income groups when his sons are 10 to 17 years old, it is possible for his sons to set themselves apart from the low-income groups via some kind of mechanisms. That is why the intergenerational income elasticity is lower at bottom quantiles in the rural area. (2) The intergenerational income elasticity approaches the peak at the top tail demonstrates that there are some mechanisms by which the fathers are much more likely to enable their offspring to remain in the high-income group. The transmission mechanism of the intergenerational income will be discussed in details subsequently.

The decomposition of the transmission mechanism of the intergenerational income

Education and occupation are two important transmission channels of intergenerational income. Here, these two channels were compared and analyzed the difference between the two mechanisms at different quantiles of income distribution.

In theory, education is one of the important transmission mechanisms of intergenerational income (Becker and Tomes, 1979; Solon, 2004). Offspring are better educated because of the human capital investment from their parents; meanwhile, the parents obtain higher return on investment. In addition, occupation is probably another important transmission mechanism. As mentioned earlier in the present study, the non-agricultural economy has been developing rapidly since the reform and opening up in China, "farmer" no longer means a

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[4] For example, Lee and Solon (2009) found the intergenerational income elasticity in USA is 0.44 on average, and the estimated intergenerational income elasticity is 0.47 in Palomino et al. (2018), both are based on the PSID dataset; And Lefranc et al. (2014) based on Japanese Social Stratification and Mobility Surveys to obtain the intergenerational income elasticity in Japan is 0.35.

Table 4. The decomposition result based on the Blanden method.

Children's education		Children's occupation	
Investment coefficient λ_1	1.376	Investment coefficient λ_2	0.241
Rate of return θ_1	0.106	Rate of return θ_2	0.158
Contribution rate τ_1	0.266	Contribution rate τ_2	0.069

profession but a status instead, and then farming is no longer the only employment option for rural residents. In this context, parents can affect their children's income through their effect on their children's occupation. More specifically, the occupation channel may include two aspects: (1) Occupation inheritance. During the period of planned economy and the initial stage of reform and opening up, the phenomenon of "position replacement" and "generational succession" are normal and prevalent: Many positions are handed from parents to children unconditionally when the parents retired. After China's economic reform, although the *direct* phenomenon of "position replacement" and "generational succession" has been alleviated, the *indirect* phenomenon of "position replacement" and "generational succession", such as internal recruitment, still exist. Moreover, the influence of the parents on their children's career is more about the subtle influence of the family growth environment. The children's life habits are formed unconsciously by growing up in a particular family, thereby they tend to enter the labor market which their parents are familiar with. For example, a child whose father is a carpenter is more likely to do similar kind of work when he/she grows up. (2) Social connections (Chinese "Guanxi"). Nowadays, a large number of employment information in China's labor market are still opaque and asymmetric. The larger the patents' social network is, the more information can be gathered to help their children to search out and select the "good" career opportunities. On the other side, the "favor" still plays a vital role in China's present labor market because the open recruitment in competitive market coexists with the planned recruitment based on personal connections.

Table 4 shows the decomposition result of the intergenerational income transmission mechanism based on the Blanden method. It can be seen that the proportion of education of children in the intergenerational income transmission is 26.6%, which has certain explanatory power, and is consistent with previous research (Fan, 2016; Qin, 2016; Palomino et al., 2018). It can be found from further observation that the influence of parents' income on children's education is much greater than the rate of return of the education of children. The proportion of occupation of children is 6.9% in the intergenerational income transmission. It can be found from further observation that the investment impact of the parents' income on children's occupation is also greater than the rate of return of the occupation of children. Compare the role of education to the role of

occupation in intergenerational transmission; the contribution rate of education is approximately 3.8 times the contribution rate of occupation. The investment coefficient of education is much higher than the investment coefficient of occupation, while the return rate of education is slightly lower than that of occupation.

Combining the quantile regression estimations with the Blanden decomposition method, we further investigate the roles of education and occupation in intergenerational income transmission at different quantiles. As displayed in Figure 2, the contribution rate of education is higher at the bottom of quantiles income; it exceeds 40% at 10th percentile. As the quantile moves to the upper part of distribution, the contribution rate of education rapidly descends at the 30 to 60th percentile, and then steeply rises to around 15% at 90th percentile. The results are in accord with the results of Palomino et al. (2018), which also found a trend of decreasing first and then increasing and the contribution rate of education reaches a maximum at the bottom quantile, while the contribution rate of occupation shows an inverted U-shaped relationship, peaking at the 30 to 60th percentile.

The decomposition results of education and occupation at different quantiles demonstrate that the intergenerational income transmission is through the channel of education at the tails of income distribution. To be more specific, at bottom quantile of income distribution, children can be disengaged from the low-income group in adulthood by a much higher probability if the parents attach more importance to education more and give their children a better education (The intergenerational income elasticity at 10th percentile as shown in Figure 1). At upper quantiles of income distribution, the children's income will also increase if their parents are able to invest more on their education (The intergenerational income elasticity reach the maximum at medium and upper percentile as shown in Figure 1). At medium part of income distribution, occupation is the main transmission channel of intergenerational income. In other words, occupation inheritance and social connections derived from the parents have great influence on the children's occupation, then further affects the children's lifetime income.

Conclusion

Reasonable intergenerational income mobility is helpful to alleviate the social pressure caused by the income gap,
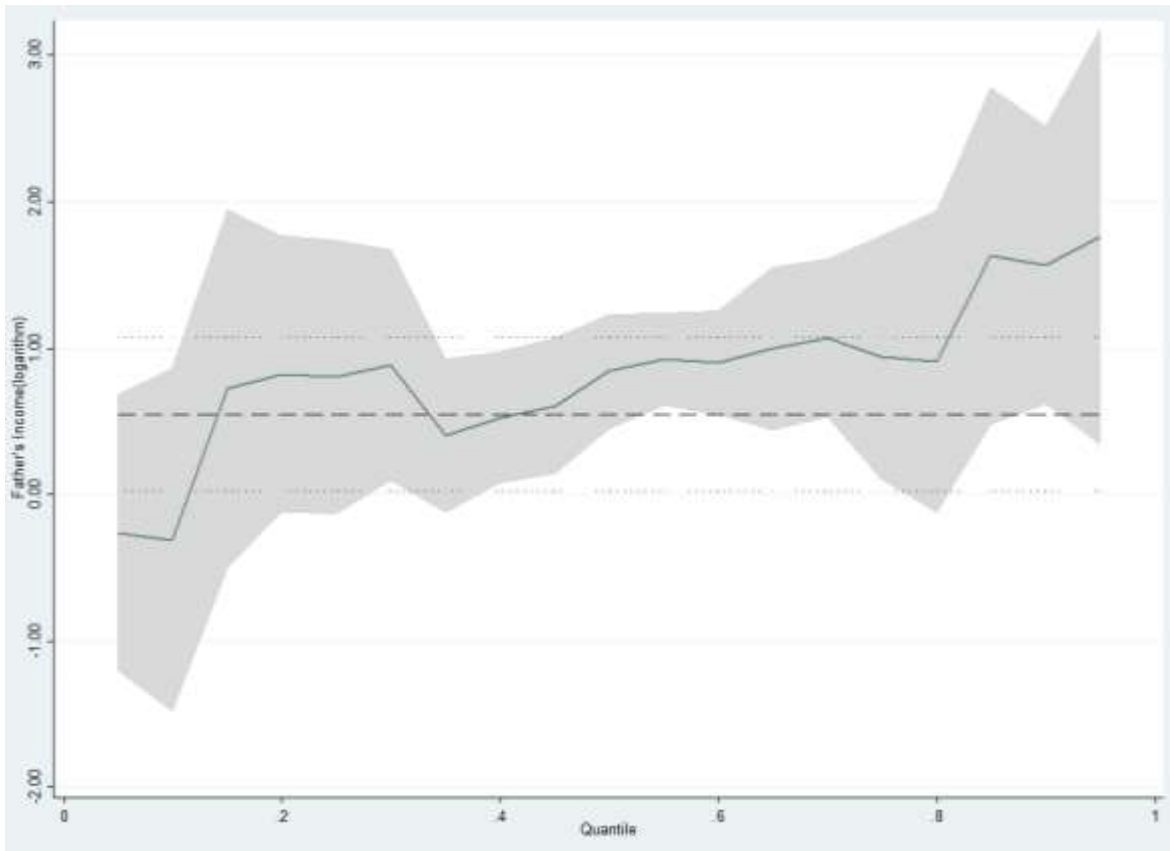
Figure 1. The coefficient of the father's income (Quantile regression).
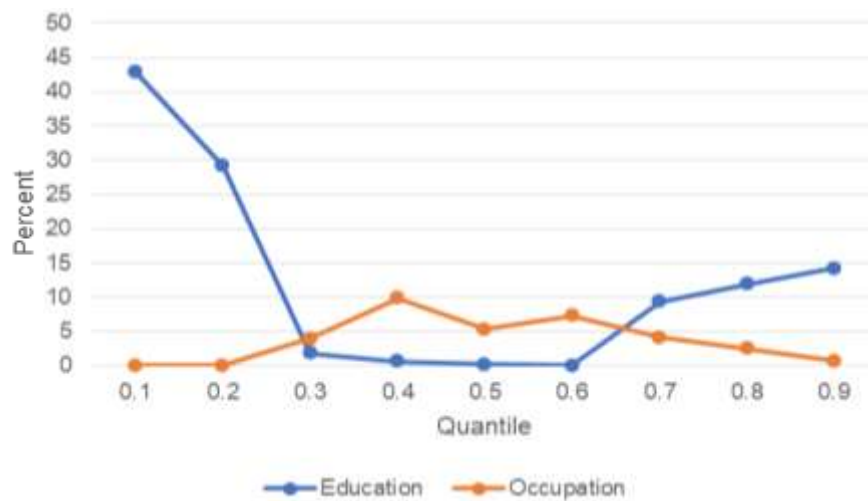
Figure 2. Impact of education and occupation in different income quantiles.

and stimulate people to work hard and make an investment in human capital, which is of great practical significance to current economic development of China. Based on the data of China Health and Nutrition Survey (CHNS) spanning from 1989 to 2015, the intergenerational income mobility and transmission mechanism of rural residents were analyzed. The estimation results indicate the following.

First, the OLS estimation of father and son yields a value of 0.549, which means a 10% increases in fathers' income will on average lead to a 5.49% increase in their sons' income. Compared with the research focused on China as well as other countries, the intergenerational income elasticity in rural China is higher, namely the mobility of intergenerational income in rural China is relatively lower. The quantile regression results show that, the intergenerational income elasticity for rural residents shows a steadily upward trend, which is consistent with the results of the existing research that the intergenerational income elasticity is higher at the upper quantiles. But different from the existing research, the present study found that the intergenerational income elasticity is lower at the bottom quantiles.

Second, the human capital investment represented by the schooling years of the children is indeed an important factor explaining the rural intergenerational income mobility, and its contribution rate is 26.6%. The social capital investment represented by the occupational type of children plays a less important role in the intergenerational income transmission mechanism for rural residents. Its contribution rate is probably 6.9%. At bottom quantile of income distribution, children can be disengaged from the low-income group in adulthood by a much higher probability if the parents attach more importance to education more and give their children a better education. At upper quantiles of income distribution, the children's income will also increase if their parents are able to invest more on their education. At medium part of income distribution, occupation is the main transmission channel of intergenerational income. The results of this study indicate that the promotion of education fairness in the rural areas will have positive effects on rural intergenerational income mobility through the further popularization of education, especially improving educational resources in low income groups.

Of course, because of the limitation of the data, the following shortcomings may exist in the present paper. The fact that the children settled in the city was not taken into account. Theoretically, the parents and their children have been decomposed into two families, of which the parents belong to the rural population and the children belong to the urban population, while CHNS data can only be traced to the former. In this case, the intergenerational income elasticity may be underestimated in this study.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Full Length Research Paper

Transportation infrastructure of Pakistan's agricultural export

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Pakistan has the highest potential for agri-business development and global marketing. This study responded to standing views about the importance of infrastructure for agricultural trade in Pakistan. It raises the concern to investigate the basic trade facilitation for the transportation of agricultural commodities. This research focuses on transport infrastructure being basic distribution drives. A gravity model is used for panel analysis of twenty countries for the period 2005 to 2015, to find the push and pull factors that contribute to agriculture exports of Pakistan. Fixed effects or random effects technique is employed based on the Hausman's test to investigate the effect of transport infrastructure (ports, air and road) on agricultural exports of Pakistan. Guided by results, it infers that improved ports facilitation can promote the agriculture sector of Pakistan as majority of trade activities are performed through ports because of their cost-effectiveness. Likewise, air network affects agricultural exports positively owing to the reduced time it takes for the air cargo to reach the destination country. Improved connectivity through roads is required to speed up the process across the regions effectively.

Key words: Infrastructure, Pakistan, agriculture exports, gravity model, panel analysis.

INTRODUCTION

The access to international markets is limited in developing countries owing to the poor infrastructure. The physical infrastructure and logistics such as roads, railways, air and sea cargo are considered essential to distribute goods worldwide. It boosts agricultural trade by reducing the transaction and distribution costs. In the global context, agricultural production in Pakistan is fairly decent despite the weaknesses in infrastructure (FAOSTAT, 2016). However, it does not hold strong position in world's agricultural trade. This study therefore, responded to standing views to explore the impact of infrastructure on agricultural exports of Pakistan which has highest potential for agri-business development and global marketing. The agricultural exports constitute 17% of total exports which consists of rice, citrus, mangoes, furniture, cotton fiber, clothing, textiles, sports goods, leather goods, rugs, carpets, chicken, livestock meat, wheat, powdered milk, seafood and fisheries at large (GoP, 2014). Figure 1 shows that the agricultural exports in Pakistan increased after 2006 as a result of the Free
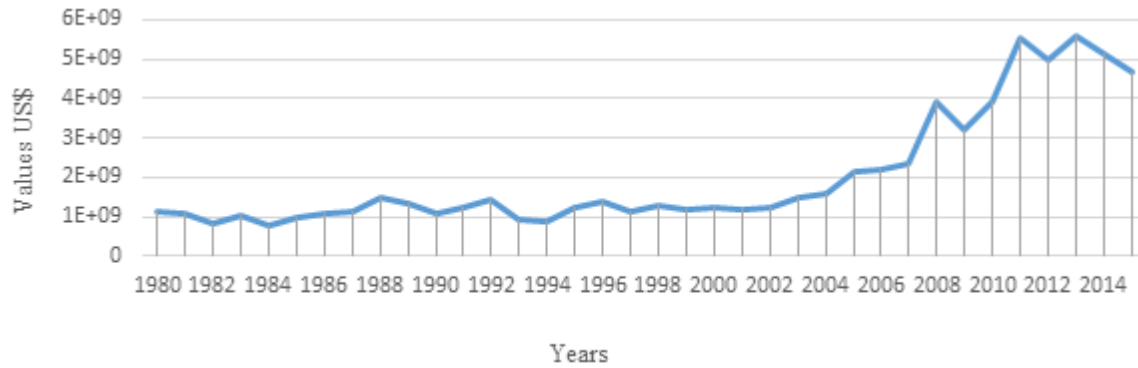
Figure 1. Pakistan agricultural exports.
Source: World Development Indicators (WDI, (2016).

Trade Agreement signed between China and Pakistan that led to an increased share of China's in total exports from 4 to 10% in upcoming years (NTC, 2015). However, it is hovering around at the same level since 2011 and is relatively declining after 2013 to 2014. Pakistan is facing major problems of energy shortage, weak infrastructure and higher cost of establishing businesses whereby its ranking deteriorated to 128th on the ease of doing business index of the World Bank, which was 96th as at 2011.

The transportation of agricultural output and exports in the global market is a key issue in Pakistan. A significant hindrance to Pakistan's economy is that 4 to 6% of gross domestic product (GDP) is lost per year due to inefficient transport infrastructure. Around 96% of freight vehicles are overloaded with goods and travel at an average speed of 20 to 25 km/h, while in Europe, the average is closer to 80 to 90 km/h. From northern to the southern Pakistan ports, it takes four days by road, which is double the time the same distance takes in European countries. The railway sector carries only 4% of freight and due to poor maintenance, the railways cannot meet the demand for freight cargo. Despite high demand, fruit exports are limited by the lack of direct flights, a shortage of air cargo space, and poor cargo handling. In the shipping sector, container handling is inefficient and costly compared to other South Asian countries in the region (GoP, 2016). The incompetence of other modes of transport has resulted in 95% of the trade in Pakistan being carried out by sea (Hussain et al., 2014). Thus, in Pakistan the high transportation costs and poor physical infrastructure have restrained exports of the agricultural products. The country where 62% of the population is living in rural areas, enough resources are not being devoted to agricultural infrastructural development. The lack of resources leads to an increase in the cost of production and surge in prices of food grains and commercial crops, reducing product surpluses and encouraging food imports. The imports become only respite to the issue of food security. Thus, it is necessary to improve delivery services and its internal and international competitiveness. The investment in infrastructure in low income countries increases the nation's agricultural production and exports. To mitigate the issues under consideration, there is a need to explore the role of infrastructure, for enhancing export volume. A better quality of infrastructure will help improve delivery services for agricultural sector and thus, surpluses to increase agricultural exports.

The study is conducted with the aim to explore and examine the impact of transport infrastructure on agricultural exports in Pakistan. Few studies exist in the empirical literature, which examine the competitiveness of Pakistani agricultural exports (Akhtar et al., 2009) or the agricultural trade potential between Pakistan and India (International Trade Center (ITC), 2013). Amjad et al. (2012) examined the impact of physical infrastructure and energy crisis on the overall exports of Pakistan, rather than the agricultural exports. Ahmed and Mustafa (2016) studied the prospect of future growth in agricultural sector including agricultural exports, as a result of better physical infrastructure after implementation of China Pakistan Economic Corridor (CPEC) project for infrastructure.

Theoretically, inefficient infrastructure affects trade by raising the incurred costs of fuel usage, public tolls, tariffs and time costs. This speaks for the "Iceberg melting" model presented by Samuelson (1954). Further, the role of expenses for trading is modeled by Fujita et al. (1999), with distinct localities in finite number. The underlying assumption is that various types of goods are produced in one location and all variants under the same location adopt the same price and technology. However, in each case, authors believe that aggregate trade of goods specific to a certain area are affected by the transport charges to all ends.

Pakistan's trade has been heavily dependent on agricultural based exports, with textile manufactures accounting for 51% of the exports, other manufactures accounting for 24% and food exports for 17%. The export

patterns have provided support to Pakistan's economy in a condition, when the country lacks proper supporting infrastructure and the focus is not on agricultural development. The relevance of infrastructure in the development policy of a country is unquestionable. The amount of rigorous research conducted in this area is very low and not much emphasis has been placed on the impact of large-scale infrastructure on trade. Moreover, infrastructure of such a scale is often built in areas that guarantee fast growth in future; for instance, roads are often built in areas that connect only high economic potentials zones

For any agricultural based economy, such as Pakistan, the quantity and quality of the products is related to global access for competitive price, ready disposal and financial gains for the growers. In Pakistan, all these factors need a massive improvement. The miserable condition of transportation infrastructure in Pakistan is barrier to positive outcomes. Therefore, the study focused to find empirically the significance of transportation infrastructure for agricultural exports of Pakistan. The study contributes to the existing research by employing a gravity model which has not previously

been done. Moreover, transportation infrastructure for Pakistan and the trading partners is considered to examine its impact on agricultural exports of Pakistan. This is significant because agricultural sector development is reliant on timely and widespread delivery to the deficient regions nationally as well as globally. This concerns the availability and security of food for larger populations and incentive to agriculturists for quality output. The improvements in infrastructure based on these findings will benefit the economy through higher agriculture trade and, the population at large by providing access to food.

METHODOLOGY

This study employs three types of transport infrastructure namely road, ports and air transport to estimate its impact on agricultural exports. Following Ismail and Mahyideen (2018), this study uses gravity model to examine the pull and push factors triggering agriculture trade between Pakistan and the rest of the world. Gravity models are used consistently to identify the key factors affecting the volume of trade (Helpman, 1998). The present study has selected agricultural exports as a proxy for agricultural trade.

$$lnEXP_{j,t}\;\Theta_0 + \Theta_1 lnGDPCT_{j,t} + \Theta_2 ln\,ENDW_{j,t} + \Theta_3 lnDIST_j\; + \Theta_4 LNG_j + \Theta_5 ER_{j,t} + \Theta_6 InTINF_t + \Theta_7 InTINF_{j,t} + +\mu_j + \mu_{jt}\quad (1)$$

where t denotes time series from 2005 to 2015; j = 1 to 19 representing nineteen trading partners (Appendix 1B) of Pakistan; $EXP_{j,t}$ = exports to country j at time t; $GDPCT_{j,t}$ = product of GDP per capita of Pakistan and the foreign economy in period t (Proxy for economic size); $ENDW_{j,t}$=endowment, comparative measure taking difference of GDP per capita between partner j in period t. $DIST_j$=distance between capital cities of exporter and economies j; LNG_j=dummy if partners have common language, 1 otherwise 0; $ER_{j,t}$ =Exchange rate of exporting country in US$.

Transport infrastructure (TINF) variables used in Equation 1 are defined as: $ROAD_t$=Road density for exporting country in time t; $ROADF_{t,j}$ =Road density for importing country in time t; AIR_t =Air transport registered carrier in numbers for exporting country in time t; $AIRF_{t,j}$ =Air transport registered carrier in numbers for importing country in time t; $PORT_t$, =Containers port traffic (TEU: 20 foot equivalent units) for exporting country in time t; $PORTF_{t,j}$= Containers port traffic (TEU: 20 foot equivalent units) for importing country in time t; *Θ's* are the coefficients, μjt is the random error term and μj is the country-specific error term.

As this study applies to one exporting country, so the subscript "i" is left out. Hence, export varies around recipient countries "j" (Bergstrand, 1985).

Transportation infrastructures namely road, air transport and port facilities are important determinants in successful completion of the trade flows for agricultural goods trade. In this regard, literature suggests few other factors, which are important for trade costs and have diverse significance by time (Olper and Raimondi, 2009). The factors responsible for divergence in trade cost are lingual, geographical, historical and cultural elements.

The economic size is presented in terms of the product of GDP per capita (proxy) for both host and source country. The chances to build more trading links increase respective to the size of the economy. Difference of GDP per capita in absolute terms is taken as relative endowment for exporting and importing economy which indicates the relative development levels of two economies, and similar income level economies like to trade more, so the effect of

relative endowment is expected to be negative on agricultural exports. Measure of distance between the economies are supposed to have negative effects when the economies are, more likely to have higher transportation cost and will result in a depletion in trade. Language barriers are also likely to have negative influence on trade, as it costs more to information. The hike in exchange rates impacts positive effect on trade reduces the commodity prices for importers hence increasing the trade flow. However, it may have negative effects as well by reducing commodity prices in turn. This study is drawn heavily from Narayan and Nguyen (2016). So following that, the primary independent variables are GDP per capita, endowment, distance, exchange rate and language as aforementioned. Following Nguyen (2010) and Narayan and Nguyen (2016), this study uses these variables to control the biases as the sample of countries to use for this research are mixed economies.

The trade related infrastructure such as transportation (road, air and ship freight) (Solakivi et al., 2009; Márquez-Ramos et al., 2011), are included in the model to capture the effect on agricultural exports by infrastructure types in this study. The improved roads, rails, air and port infrastructure influences the agricultural trade positively. Dependent variable is derived as the value of agricultural exports in United State of America dollars (US$) from the exporting country, that is, Pakistan in this context. Data for the variables is taken from 2005 to 2015. Sources of data are United Nations COMTRADE database, World Bank and CEPII. The independent variables for gravity model include distance, endowment, language, exchange rate and economic size as used by Narayan and Nguyen (2016). Summary of the variables is presented in the Appendix 1A.

Panel data analysis

Generally, the random effect model uses a weighted average between and within variations, which does not take in all the information but is more appropriate if the panel data comprises of *N*-individuals drawn randomly from a large population, such that the

μ_i is randomly distributed across countries or cross-sectional units. The fixed effect model uses within variation only in the data, and allows the endogeneity of the regressors. This model is more appropriate when focusing on a specific set of *N* firms or countries that are not randomly selected from a large population. A major drawback of the fixed effect model is that separate intercept terms are used for each cross-sectional unit, which can use up degrees of freedom very quickly.

To make the right decision for choosing a model, two basic tests are implemented. First to decide whether data should be simply pooled instead of using random effects or fixed effects, the Breusch-Pagan, Lagrangian Multiplier (LM) test is employed.

$H_0: \sigma_\mu^2 = 0$ (Pooled OLS)
$H_1: \sigma_\mu^2 > 0$ (Random Effect)

LM requires the OLS residuals $\widehat{\varepsilon_{it}}$. it is given as:

$$LM = \frac{NT}{2(T-1)} \left[\frac{\sum_{i=1}^{N}(\sum_{t=1}^{T} \widehat{\varepsilon_{it}})^2}{\sum_{i=1}^{N} \sum_{t=1}^{T} \widehat{\varepsilon}_{it}^2} - 1 \right]^2$$

where LM is distributed as chi-squared, with one degree of freedom under the null hypothesis; rejecting null hypothesis would indicate that variation among the data is strong enough that it should not be pooled together.

To choose between random and fixed effect models, Hausman test is incorporated. The hypotheses are as follows:

$H_0: Cov\,(\mu_i, x_{it}) = 0$ (Random Effect)
$H_1: Cov\,(\mu_i, x_{it}) \neq 0$ (Fixed Effect)

Hausman test statistics has an asymptotic chi-squared distribution with k degrees of freedom under the null hypothesis of regressor-effect independence (RE is appropriate). If the test statistic is large enough, fixed effect model should be used. This implies that rejection of null hypothesis indicates that the co-variance between independent variable and cross sectional unit's specific effect is absent. Further, Hausman's test statistics suggest that in case of an individual country, specific effect is largely independent, making fixed effect model a more appropriate choice for the estimator. However, if the co-variance is present, then the country specific effect is not independent of the explanatory variable. Therefore,

random effect estimator would provide a consistent estimation (Gujarati and Porter, 2009).

RESULTS

Descriptive statistics

Table 1 shows the summary statistics of all the variables used in the study. Minimum and maximum values with mean and standard deviation are given in raw form for all the variables used to see the impact of infrastructure on agricultural exports of Pakistan. The correlation matrix of independent variables in Equation 1 is shown in Table 2.

In the correlation matrix for Equation 1 shown in Table 2, it can be seen that product of GDP per capita (GDPCT) is highly correlated with difference of GDP per capita (US$) between exporting and importing countries (ENDW) and exchange rate (ER). Amongst the primary variables of interest, ROAD is highly correlated with air transport registered carrier in numbers (AIR) and ship containers (PORT) whereas AIR is highly correlated with PORT. Such correlations require the use of multicollinearity diagnostics whereby in the case of high VIF and low tolerances, equation 1 would have to be readjusted.

Table 3 shows the outcome of multicollinearity diagnostics. It can be observed that road and port have low tolerance values which indicate that it is preferable that all three forms of transport infrastructure are incorporated in separate models respectively. The corresponding values of GDPCT and ENDW are also low. However, since these are control variables, omitting them from the gravity model may lead to inefficient outcome. Therefore, they are included in all the equations. For clarity models A, B and C are reported as follows:

Model A:

$$EXP_{j,t} = \Theta_0 + \Theta_1 GDPCT_{j,t} + \Theta_2 ENDW_{j,t} + \Theta_3 ER_{j,t} + \Theta_4 ROAD_t + \Theta_5 ROADF_{j,t} + \mu_j + \mu_{jt}$$

Model B:

$$EXP_{j,t} = \Theta_0 + \Theta_1 GDPCT_{j,t} + \Theta_2 ENDW_{j,t} + \Theta_3 ER_{j,t} + \Theta_4 AIR_t + \Theta_5 AIRF_{j,t} + \mu_j + \mu_{jt}$$

Model C:

$$EXP_{j,t} = \Theta_0 + \Theta_1 GDPCT_{j,t} + \Theta_2 ENDW_{j,t} + \Theta_3 DIST_j + \Theta_4 LNG_j + \Theta_5 ER_{j,t} + \Theta_6 PORT_t + \Theta_7 PORTF_{j,t} + \mu_j + \mu_{jt}$$

Diagnostic analysis

Results of diagnostic analysis are shown in Table 4. To choose between random effects estimator and POLS, the Breusch-Pagan LM test is considered. Rejection of the

test indicates that there is enough variation in the country specific error term, thus, data cannot be pooled due to heterogeneity and random effects estimator should be preferred over POLS. To choose between random effects estimator and fixed effects estimator, Hausman test is

Table 1. Summary statistics.

Variable	Mean	Standard deviation	Minimum	Maximum
EXP	52.1	55.6	0.3428677	340
GDPCT	122	102	7.395631	411
ENDW	25984.86	23293.99	0.9	94023.5
DIST	5174.414	2737.093	683.345	11392.38
LNG	0.421	0.494	0	1
ER	700.984	2276.292	0.268	13389.42
ROAD	32.954	0.374	32.401	33.612
AIR	59064.75	8488.268	48903.29	72692.98
PORT	2152843	291613.6	1686389	2597344
ROADF	108.622	146.612	7.3	572.836
AIRF	871487.7	2169799	0	10100000
PORTF	18900000	32100000	238613.4	182000000

Table 2. Correlation matrix

Explanatory variable	GDPCT	ENDOW	ER	DIST	LNG	ROAD	AIR	PORT	ROADF	AIRF	PORTF
GDPCT	1	-	-	-	-	-	-	-	-	-	-
ENDW	0.945	1	-	-	-	-	-	-	-	-	-
ER	-0.719	-0.683	1	-	-	-	-	-	-	-	-
DIST	-0.025	-0.112	0.141	1	-	-	-	-	-	-	-
LNG	-0.103	-0.121	0.012	0.376	1	-	-	-	-	-	-
ROAD	0.081	-0.002	0.0170	0.014	0.000	1	-	-	-	-	-
AIR	0.055	0.015	0.007	0.012	0.000	0.649	1	-	-	-	-
PORT	0.083	0.008	0.013	0.016	0.000	0.935	0.701	1	-	-	-
ROADF	0.528	0.550	-0.375	0.348	0.081	0.068	0.052	0.069	1	-	-
AIRF	0.319	0.339	-0.370	0.107	0.140	0.047	0.045	0.054	0.375	1	-
PORTF	0.324	0.398	-0.046	0.063	-0.002	0.062	0.050	0.060	0.216	0.321	1

Correlation analysis of the variables shown represents their natural logarithmic value.

Table 3. Multicollinearity diagnostics.

Variable	VIF	Sort VIF	Tolerance
GDPCT	13.7900	3.7100	0.0725
ENDW	12.6300	3.5500	0.0792
ER	2.8600	1.6900	0.3497
DIST	1.9400	1.3900	0.5161
LNG	1.4300	1.2000	0.7000
ROAD	8.2400	2.8700	0.1213
AIR	1.9700	1.4000	0.5066
PORT	9.1900	3.0300	0.1088
ROADF	2.2300	1.4900	0.4478
AIRF	1.5600	1.2500	0.6406
PORTF	1.5100	1.2300	0.6609

undertaken. Rejection of Breusch-Pagan LM test indicates that country-specific effect is significant and each country should be included in the form of a dummy variable in the empirical model or, in other words, LSDV model would be preferred over random effects estimator. Once the most appropriate estimator is selected, other

Table 4. Diagnostic analysis.

Diagnostic test	Model A	Model B	Model C
	(Dependent Variable: EXP)		
Breusch-Pagan LM test	309.81***	300.68***	302.84***
Hausman	12.41*	20.10***	6.72
CSD	9.652***	8.244***	3.332***
First order autocorrelation	6.373**	7.048**	4.244**
Groupwise heteroskedasticity	1427.27***	1680.64***	109.2580***

***, ** and *, Indicates significance <1, <5 at <10%.

diagnostics are performed to ensure the reliability of the estimates in the empirical models. The diagnostics include testing the presence of autocorrelation, heteroscedasticity across panels and cross-sectional dependence (CSD).

It can be observed that the Breusch-Pagan LM test is consistently emerging significant, which shows that random effects estimator is better than POLS for all models. In the context of random effects and fixed effects estimators, the Hausman test statistics for models A and B show the latter should be preferred over the former, whereas the statistic for model C show that random effects estimator should be preferred over both POLS and fixed effects estimator. All the models show the presence of serial correlation, group wise heteroscedasticity and CSD. To cater for such issues, the Driscoll-Kraay standard errors have been considered. Under these standard errors, the error structure is assumed to be heteroscedastic, auto correlated and possibly correlated between the panels which in this case are countries. This nonparametric technique of estimating standard errors does not place any restrictions on the limiting behavior of the number of countries. Hence, such standard errors can produce more robust results under the stated issues. For models A and B, the Driscoll-Kraay standard errors are estimated with fixed effects regression and for model C, the standard errors are estimated with POLS regression. For robustness, the results of fixed effects estimator for models A and B and the random effects estimator for model C under robust standard errors are also reported. Another issue is that under the fixed effects estimator, the time invariant variables such as language and distance have to be omitted as fixed effects estimator only picks up the effects of those factors that vary over time (Ismail, 2008).

Regression analysis

The regression results are shown in Tables 5 and 6. Among the control variables, GDPCT appears as significantly positive in majority of the models as expected in theory and empirically. Combined GDP per capita between Pakistan and trade partners revealed a positive relationship which implied that the larger market size the higher agriculture trade. Negative coefficient of endowment (ENDOW) in the regression outcome is observed in models 1B, 1C and 2B. So Pakistan's agricultural exports do not increase as the GDP difference between Pakistan and trading partners increase. The coefficient of exchange rate (ER) is emerging as positive in models 1A and 1B with a statistically significant coefficient in the latter. A 1% increase in ER is leading to a 0.85% increase in agricultural exports (EXP) in model 1B and 2B and 0.1421% decrease in model 2C. Distance (DIST) is consistently emerging as negative and significant in all the models as expected. Coefficient of language (LNG) is positive but insignificant. The primary variables of interest representing physical infrastructure namely road and port are appearing significantly positive. Air transport (AIR) significantly impacts the EXP positively while insignificant impact of foreign air transport (AIRF) is observed. A 1% increase in port facilities (PORT) lead to a more than 3% increase in the value of agricultural exports of Pakistan. Detailed discussion of the results is described subsequently.

DISCUSSION

Theoretically, if the difference between economic development stage of Pakistan and the trading partner is low, that is, the endowment (ENDW) has low value; the EXP demand from Pakistan will increase. It can be inferred that a trading partner belonging to a third world may hold the capability to afford more agricultural exports from Pakistan in comparison the one belonging to high income or upper middle income status, which may prefer purchasing EXP from other rapidly developing or developed economies, making use of better quality standards existing in such countries. Negative coefficient of ENDOW indicates that most of Pakistan's EXP are channeled towards relatively more developed economies that have high endowments of strategic assets and other resources.

As the value of exchange rate increases or as it depreciates against US$, the exports become cheaper

Table 5. Regression results; fixed effects and random effects with robust standard errors.

Explanatory variable	Model 1A	Model 1B	Model 1C
	Dependent variable: EXP		
GDPCT	1.1743* (0.6701)	1.7630*** (0.6016)	0.0687 (0.2457)
ENDOW	-0.0598 (0.0389)	-0.1301*** (0.0339)	-0.1000*** (0.0293)
ER	0.5234 (0.3837)	0.8525** (0.3062)	-0. 0591 (0.0710)
ROAD	20.9882*** (5.9376)	-	
ROADF	0.4672 (0.2783)	-	-
AIR	-	1.7447*** (0.4598)	-
AIRF	-	0.0100 (0.0561)	-
PORT	-	-	3.1996*** (0.5524)
PORTF	-	-	0.2527*** (0.0575)
DIST	-	-	-0.4538** (0.1942)
LNG	-	-	0.3301 (0.3604)
Constant	-79.8646*** (21.2316)	-34.6886*** (12.1088)	-29.8074*** (8.4913)
R-Squared	0.3546	0.3743	0.4170

***, ** and *, Indicates significance <1, <5 at <10%.Standard errors reported in the round parenthesis. Model 1A and 1B: Fixed effects regression with robust standard errors. Model 1C: Random effects regression with robust standard errors.

Table 6. Regression Results: fixed effects and pols regression methods with driscoll-kraay standard errors.

Variable	Model 2A	Model 2B	Model 2C
	Dependent Variable: EXP		
GDPCT	1.1743*** (0.3575)	1.7630*** (0.3601)	-0.0154 (0.3369)
ENDOW	-0.0598 (0.1032)	-0.1301** (0.1350)	-0.1861 (0.1218)
ER	0.5234 (0.4370)	0.8525* (0.3921)	-0.1421*** (0.0359)
ROAD	20.9882** (7.3130)	-	-
ROADF	0.4672** (0.1649)	-	-
AIR	-	1.7447*** (0.4688)	-
AIRF	-	0.0100 (0.0569)	-
PORT	-	-	3.3077*** (0.2032)
PORTF	-	-	0.2329*** (0.0350)
DIST	-	-	-0.4123** (0.1439)
LNG	-	-	0.2653 (0.2314)
Constant	-79.8646*** (23.0770)	-34.6886*** (5.9910)	-28.8799*** (4.9237)
R-Squared	0.3546	0.3743	0.3821

***, ** and *, Indicates significance <1, <5 at <10%. Standard errors reported in the round parenthesis. Model 2A and 2B: Driscoll-Kraay standard errors with fixed-effects regression method. Model 2C: Driscoll-Kraay standard errors with POLS regression method.

and ultimately, increase. The exchange rate of Pakistani Rupee (PKR) has been continuously depreciating, encouraging exports from the agricultural sector. However, continuous depreciation also increases the price of essential imported products, indicating economic issues such as current account deficit and more expensive overseas investment. The subsequent rise in the cost of production for the business sector and low profits earned from low value added exports, adversely affected the exports from agricultural sector; therefore, the unexpected negative sign of ER in model 1C is witnessed. Hence, the policymakers must address the

issues arising from ER depreciation and interpret the positive sign of ER in a cautious manner.

The coefficients of time invariant variables such as distance and language also demonstrate expected outcomes. More DIST between Pakistan and destination country, the transportation costs becoming more expensive with increase in the export, ultimately discouraging the EXP. Similarly, higher resemblance in the official/spoken languages in Pakistan and importing countries attracts more agricultural exports from Pakistan. However, insignificant coefficient of language indicates that it is not a crucial pull factor responsible for higher EXP. Other economic factors such as, economic development stage of Pakistan, GDP per capita and DIST hold more importance in determining the extent of exports in agricultural sectors from Pakistan to other countries worldwide.

An improved infrastructure in the context of more comprehensive road network allows the agricultural output to be transported more efficiently around different parts of the country. As it becomes more cost-effective to supply the products, especially the perishable agricultural products, it becomes easier to transport the output to airports and seaports which increases the amount of EXP. According to Mcquaid (2016), in Pakistan, as the urban areas are developing at a rapid pace, the demands for agricultural products are also increasing. The expansion of urban areas assisted in forming better transport network that permitted the connection of agricultural farms to cities via paved and high-quality roads over time. Moreover, the Silk Road has remained oldest and a cost-effective route for trade that connects Pakistan with China (Ahmed and Mustafa, 2016). However, there are still many areas in rural Punjab and Sindh provinces that are not connected to mainstream cities which restrict the growth in agricultural output and EXP. Therefore, the formation of CPEC, which includes improvement of Silk Road, other transport networks and physical infrastructure, is considered to be a beneficial step towards increasing the agricultural output and raising EXP. In view of the positive relationship between ROAD and EXP, the similar initiatives are needed to further increase agricultural exports, as they at the provincial level or at the national level. The less than proportionate impact of ROADF on EXP shows that presence of better road networks in the foreign economies may act as a push factor responsible for higher EXP from these economies, rather than acting as a push factor behind higher imports from Pakistan, as majority of the EXP are transported via ocean and therefore, seaport facilities and their networks, rather than the road networks, play a more important part in trade of goods worldwide (World Industrial Reporter, 2012).

A better quality of air transport network acts as a crucial push factor responsible for higher agricultural exports owing to the reduced time it takes for the air cargo to reach the destination country. Although Pakistan Civil Aviation Authority (CAA) charges higher amounts for agricultural exports, especially for perishable products such as fruits and vegetables, from the local exporters (Hussain, 2010), the disadvantages are overpowered due to the quicker deliveries of the agricultural exports. Hence, more efficient and cost-effective air transport networks are desirable to assist high AIR in further increasing EXP. The current air transport networks for export of fresh fruits and vegetables in Pakistan are insufficient as stated by Maqsood (2018). Owing to the positive relationship between EXP and AIR, this indicates that EXP might be adversely affected if such situation continues. The insignificant impact of AIRF displays that Pakistan's agricultural export (EXP) forms a low proportion of total agricultural exports in majority of the export destinations as previously mentioned. Therefore, even if the AIRF increases, the change in EXP from Pakistan is insignificant or not as positive as the EXP being received from other countries of origin. Besides, when AIRF increases, the impact is insignificant since it is a lesser used mode of transporting EXP due to higher costs.

As majority of the exports in Pakistan are performed through ports because of their cost-effectiveness. Thus, creation of more seaports and improvement of the physical infrastructure on these ports substantially impacts the EXP positively, which would also strengthen the economy of Pakistan. Gul (2017) stated that the initiative taken by the Chinese investment under mega project namely China Pakistan Economic Corridor (CPEC), has a prominent feature of upgrading and establishing Gwadar deep seaport as a regional giant promoting Pakistani exports to the Middle East, Central and South Asian regions. Since Gwadar Deep Seaport is located at the convergence of these regions; it bears an immense strategic importance that can be exploited to serve the existing markets and explore new markets for EXP, leading to an increase in the revenues of agricultural exports and further, strengthening the relationship between PORT and EXP. Moreover, as ports of major export destinations expand, their imports of agricultural products from Pakistan also increase significantly as seaport is widely used mode of transporting agricultural exports.

Conclusion

Precisely, study concludes that physical infrastructure such as road network has significantly positive impact on agricultural exports of Pakistan which suggests more investment in building effective road network. Thus, enhanced connectivity of rural areas to the highways is crucial to reap the benefits from other mega projects such as CPEC.

Moreover, agricultural output can be exported across

various regions through enhanced airport network and increasing the number of flights. Owing to positive relationship between air infrastructure and agricultural exports, reduced fares to a certain extent can considerably boost exports of agriculture sector.

Present study also indicates a significant increase in agricultural exports owing to sea port infrastructure in both exporting and importing countries as seaport is widely used mode of transporting agricultural exports. Further improvement and expansion of facilities in existing seaports and establishing new seaports would provide a more cost effective route for transporting output, such as; strategically positioned Gwadar seaport. It would contribute substantially to export revenue of the country.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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APPENDIX

Appendix 1A. Summary of the variables.

Variable	Source	Expected signs
Dependent		
EXP: Value of agricultural exports (million US$) from exporting country (Pakistan) to importing economies	UN Comtrade database	
Independent		
TINF:		
Transportation infrastructure	WDI database, World Bank	+
ROAD: Road density (km of road per 100 km2 of land area		
AIR: Air transport registered carrier in numbers		-
PORT: Ship containers (TEU: 20 foot equivalent units)		-
Control variables for gravity equation:		
GDPCT: Gross domestic product per capita in million US$ (Product of GDP per capita)	WDI database, World Bank	+
$ENDW$: Difference of GDP per capita (US$) between exporting and importing countries	UN Comtrade database	-
$DIST$: Distance between capital cities of both economies	CEPII Database	-
LNG: Common language of the trading countries	CEPII Database	+
ER: Exchange rate	WDI database	+/-

Appendix 1B. List of countries included in analysis.

Country	Code	Country	Code
Australia	AUS	Malaysia	MYS
Bahrain	BHR	Mauritius	MUS
China	CHN	Republic of Korea	KOR
Germany	DEU	Senegal	SEN
India	IND	Singapore	SGP
Oman	OMN	Turkey	TUR
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