Estimating the impact of transport efficiency on trade costs: Evidence from Chinese agricultural traders

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Abstract:

Using a unique survey data on agricultural traders in China in 2004, this study provides direct evidence on significance of inter-regional transport costs and their key determinants. Our major findings are as follows: (1) the trade barriers within China are dominated by transport-related costs but not artificial barriers, approximated by tolls and fines; (2) Labor and fuels costs are the most significant component of transport costs; (3) road quality is very important for transportation efficiency. Our results indicate that if increasing transport speed by 1 km per hour now, the fuel costs and total direct transportation costs for Chinese traders would reduce by 1.3% and 0.7% respectively.

Key Words: Transportation Costs, China, Agricultural Traders, Infrastructure

1 Introduction

Evidences in many developing countries have shown that road construction and reduction of trade barrier can improve fertilizer use, enhance domestic and international trade, increase agricultural output; boost consumption, and reduce poverty (Binswanger et al. 1993; Jacoby and Minten 2009; Khandker et al. 2009; Minten et. Al. 2005); and China is not an exception (Fan et al. 2002; Fan and Chan-Kang 2005; Huang, Rozelle and Change 2004). Pinstrup-Andersen and Shimokawa (2007) have a comprehensive review about the impacts of rural infrastructure on agricultural development.

However, the current studies find that China succeeded in reducing international trade barrier but failed at reducing domestic trade barrier after the launching of economic reform(Poncet 2003), even though China has kept on investing in infrastructure so far and the length of roads in different classes has been increasing (Fan and Chan-Kang 2005). Amiti and Jacorcik (2008) suggest that China's domestic market fragmentation is caused by underdeveloped transport infrastructure and informal trade barriers. Specifically, on the one hand, Park et al. (2002) find that much of the increase in transaction costs in China was due to transport bottle-necks in 1990s, particularly in the booming South. On the other hand, Young (2000) proposed that China Economic reform caused a fragmented internal market with fiefdoms controlled by local officials whose economic and political benefits are tied to protected local industries.

The hypothesis that market distortions in China caused by high inter-provincial trade barrier is challenged by Holz (2009) who declared that China's economic reform concerns avoiding the swamp of trade barriers, and the increasing size of highway can significantly reduce the barriers. On the other hand, it cannot be deniable that the toll fees of highways are believed to be an important component of trade barriers which is a substantial part of final prices for food products, even though Chinese governments take some special measures to reduce the transportation costs.

Regarding the trade barriers within China, there are a few improper perceptions. First, trade barriers in China remain high (Poncet 2003). Second, artificial trade barriers (e.g., due to local protectionism) is a major reason for the high trade barriers in China. (3) Energy cost is a major component of transport costs. These perceptions have not been well scrutinized.

Little evidence is available on why the trade barriers are high and what the main component of trade barriers is. Much research has focused on artificial trade barriers and extrapolates on it. For instance, Young (2000) pointed out the declining price gaps in China results from reduced local protectionism. Research focusing on the physical trade barriers, specifically, transport costs, is only conducted in a very limited way. There is a reason to believe that the system of market economy has not been well developed in China.

To this end this paper contributes new evidence, and more direct evidence to the literature. In particular, we will use a unique survey data for agricultural traders from China in 2004 to decompose the transportation costs and exam the determinants of the main components as well.

The existing literature has emphasized on the time value of passengers and its related logistics design. Very little evidence exists on the direct effect of transportation time on the transportation cost, so that simple econometric models will be used to exam the impacts of distance, road condition and transportation time on transportation cost of agricultural trade in China.

The paper is organized as follows: Section 2 introduces the approaches to decomposing transportation costs and the econometric models for estimating the determinants of main components in transportation costs; Section 3 describes the data and survey methods, which is followed by discussions of the empirical results in Section 4. Finally, Section 5 draws conclusions.

2 Empirical methodology

In this section we demonstrate how we calculate the trade barriers and their components, and infer their determinants as well.

2.1 Decomposing trade barriers

First, trade barrier can be measured by the costs incurred between purchasing and selling. Specifically, we calculate the trade barriers as the net difference of markup and profit rates:

Trade barriers = Markup Rate-Profit Rate (1)

Both the markup and profit rates are reported by the traders. The markup rate is defined as the sales revenue minus the input costs. All costs related to the behavior of trade are further deducted for the traders to calculate the profit rate. These trade costs may include those due to transport, storage, and sales tax.

Second, because transportation costs play important roles in trade barriers which is crucial for market efficiency, we can calculate the weight of transportation cost in total trade barriers (TCW),

*TCW= Transportation Cost/ (Trade barriers*Sales)* (2)

In China, traders can transport goods by themselves or by contracted transporters. We survey the detailed transportation information for both of them. In particularly, we survey the detailed information for transportation costs of self-transportation traders while the details for contracted transporters are not captured.

The total transportation costs can be break down into fixed costs and variable costs. Specifically, fixed costs include the maintenance costs, insurance expense, and some fixed taxes(such as registration costs and road-use fee); variable costs include the expenses on fuel, labor, toll, meals and lodging, and fines.

It is important to note that the tolls and fines are particularly related to the local protectionism that has been emphasized by the existing studies on trade barriers in China. Hence, we may have a direct measure of their relative importance in the costs of trade. Also note that the tolls and fines are not necessarily fully due to local governments' intention to protect local market. The tolls may reflect the costs of infrastructure (e.g., maintenance costs). The fines may reflect the social costs of transportation (e.g., accidents). In these cases, both tolls and fines should also be considered part of the transport costs.

Many traders in our sample had experience using trucks to transport. For these traders, the survey requested information on the total transportation costs and the breakdown, including the expenses on fuel, labor, toll, fines, food and lodging, and others. In the next part we will take a careful look at the determinants of fuel costs, labor costs, and total variable costs as well.

2.2 Estimating the determinants of transport costs

We consider the following models of two major components of transport costs: fuel and labor, as they are believed the most important ones.

2.2.1 Fuel Costs

$$\ln(Fuel_i) = \alpha_0^F + \alpha_1^F \ln(Dist_i) + \alpha_2^F \frac{Dist_i}{Time_i} + Z\beta^F + \gamma_j^F + \varepsilon_i^F \quad (3)$$

This model decomposes the determinants of fuel costs into four factors: the actual distance of transportation, Dist; Infrastructure quality measured by average transport speed $\frac{Dist_i}{Time_i}$; the fixed effects of the locations of traders γ_j^F, which may capture the regional variations in fuel prices; and other determinants Z, such as the trader's age, education and gender. ε_i^F is a random variable following normal distribution with a mean of zero.

2.2.2 Labor Costs

$$Labor_i = \alpha_0^L + \alpha_1^L Time_i + \alpha_2^L \frac{Dist_i}{Time_i} + Z\beta^L + \gamma_j^L + \varepsilon_i^L \quad (4)$$

The labor costs are assumed to be determined by transportation time $Time_i$, the road quality $\frac{Dist_i}{Time_i}$ capturing the suffering in transportation, regional effect γ_j^F capturing the regional difference in wage, and other determinants Z as in the fuel function (3).

ε_i^{L} is also a random variable with a mean of zero.

The econometric models of fuel and labor costs in transportation have two important implications. First, it provides a direct estimate of the importance of time to transport costs. The transport time may affect transport costs through two major channels. One is the saving of labor demand and the other is through increasing fuel-burning efficiency. This may happen because the time effect (time over distance) is a measure of the importance of infrastructure quality. Better road infrastructure may increase transport speed, thus increasing fuel-burning efficiency.

2.2.3 Total Variable Costs

We can also estimate the total effects, which may include not only the fuel and labor costs, but also other costs, such as food and lodging, fines and tolls. The model is specified as

$$\ln(TPCost_i) = \alpha_0^{\ T} + \alpha_1^{\ T}\ln(Dist_i\ ) + \alpha_2^{\ T}\frac{Dist_i}{Time_i} + Z\beta^T + \gamma_j^{\ T} + \varepsilon_i^{\ T} \quad (5)$$

The function of total transportation costs is similar with that of fuel function, including distance, road quality, regional effects , and some other demographic variables of the trade.

Sample selection biases

In theory, the estimation of the models above may suffer from sample selection bias. What we observe in the data are the costs for actual trades. Note, however, that only traders that find the transport costs low enough may make the trade. Hence, some potential trades are not observed if the costs are too high. What we observe are only the information for "low-trade costs" routes. This sample selection may generate estimation biases if some determinants of transport costs are unobserved and if they also affect the trade costs. For example, artificial trade barriers are not directly observed and may affect both the transport costs and the decision for traders to trade. If this effect is significant, it may generate the biases due to the sample selection. This sample selection bias is a major issue in applied econometric analysis (see Chapter 17 of Wooldridge, 2002, for detailed analysis).

One way to address the issue is to apply the Heckman's two-step procedure. In the first step, we would need to estimate a probit model of whether the traders at location I would trade with location j. In particular, we estimate the following model

$$Trade_{ij} = 1[\hat{Z}\varphi + \varepsilon_{ij} > 0] \quad (6)$$

Here 1[.] is an indicator function, and the trade between the location i and j can be determined by a vector of exogenous variables $\hat{Z}$, such as the demographic variables of traders and their locations. We then can obtain the inverse Mills ratio from equation (6) which can be included in the regressions of functions of transportation costs. If the coefficient of the inverse Mills ratio is significant, it indicates that the selection bias is present.

3 Data

The data used in this study are from a

face-to-face survey of wholesale market traders conducted in August and September 2004, which includes 700 traders in more than 40 wholesale markets scattered among 8 provinces: Beijing, Henan, Ningxia, Sichuan, Shandong, Shanxi, Yunnan and Zhejiang. However, after cleaning the data, we only obtained 224 samples who reported the information about trade barriers and transportation costs, and in which 162 samples use contracted transporters for transportation, 46 samples are of self-transportation and 16 are of mixed transportation.

Furthermore, the survey also obtained the information of 210 specific transportation routs

4 Empirical findings and discussions

4.1 The components of trade barriers

First we calculate the trade barriers and the share of transportation costs in trade barriers, which is the difference between markup rate and profit rate. The results are reported in Table 1.

In our 224 observations, the average markup rate is about 25.66%, and the profit rate is 7.48%, so that the trade barriers are 18.18% which is quite high. Within the trader barriers, 42.05% results from transportation costs.

Comparing the contracting transport with self-transport, we find that traders with contracted transport have slightly higher markup rate and slightly lower profit rate, so that the trade barriers for contracting transport are higher. The difference between the trade barriers might be caused by a transportation cost for contracted transportation. Eventually, the share of transportation costs in trade barriers is 44.50% for contracted transportation, while the number is only 35.01% for self-transportation. It is plausible that self-transportation might internalize some costs, or some opportunity costs are not reported by the traders.

Note that both trader barriers and transportation costs are the lowest for traders with mixed transportation both using contracted transportation and using self-transportation. It could be that these traders use portfolios of transportation meanings to minimize transportation costs and trade barriers.

In Table 1, we break down the transportation costs into fixed and variable transportation costs by the information of self-transportation, and found that about 52% are fixed transportation costs and 48% are variable costs.

We also break down the fixed costs into maintenance costs, insurance, taxes, and other fixed costs, which are reported in Table 2. We find that government taxes are 64.19% for self-transportation, which are the largest proportion in fixed transportation costs. The maintenance costs and insurance costs are only about 14.23% and 3.83%, which are not so substantial. It indicated that taxes which are artificial barriers are still very high in China.

Table 3 looks at the components of variable transportation costs. It is interesting that both all means of transportation and truck transportation have the similar structures in variable costs. Both fuel costs and labor costs are the most import parts in variable costs, and both share more than 45% in the variable costs either for all means of transportation or for truck transportation. The artificial barriers created by tolls and fines are also substantial, but less important than fuel and labor costs. In the observed samples, they are about 35% in all means of transportation and 20% in truck transportation.

4.2 Determinants of trade barriers

In this section we proceed to estimating the key determinants of the transport time: distance, time, and road quality, and their impacts on the variable transportation costs: fuel, labor and the total variable transportation costs as well. The econometric models have been shown in Section 2.

The estimation results are presented Table 4, which include the estimations for fuel function, labor function, and total variable cost, and each with a fixed-effects model and a Heckman sample selection model (Heckit). Comparing the fixed-effects model and the Heckman sample selection model, we find that their results are quite consistent. The coefficients for the inverse Mills ratio are not statistically significant for all three models, so that there are no significant evidences of sample selection problem in our study and the following discussions are mainly based on the results of the fixed-effects models.

Interestingly, the demographic variables, such as gender, education, and age are not statistically significant for transportation costs except for age in the labor cost function.

4.2.1 The model of fuel costs

The results of fuel costs function are reported in the column 1 and 2 of Table 4. The coefficient of the log of distance is 1.13, very close to one, suggesting that the fuel cost is proportional to the transport distance. Moreover, we also find that the coefficient of the variable of average speed -0.013 and statistically significant at 10% level, which suggests that road infrastructure with higher quality would reduce fuel cost. In particular, the speed increase by 1 km per hour now, which can reduce fuel costs by 1.3% due to an increase in fuel efficiency.

4.2.2 The model of labor costs

We then turn to the estimation of the labor costs model. We find that the age of trader and the transport time are statistically significant and positively related to the transport costs.

First, the coefficient for time is 23.07, which implies that the payment for a driver is about 23 yuan per hour (about US $4). While the variable of speed (a proxy for road quality) is not statistically significant. It implied that the labor costs only depend on the time, and road quality is not significant.

Second, the coefficient for age is 13.22, which implies that labor costs increase in trader's age. One can speculate that transportation is a very tough job, and old people often hire others to do it, while young people usually do that by themselves, so that some costs for the young person might not be reported in the survey. Other demographical variables, such as education and gender, are not important for labor costs in transportation.

4.2.3 The model of total transport costs

We now turn to estimating the model of total variable transport costs. This significantly increases our sample size because the traders tend to be more likely to reply the total costs. Moreover, this also allows that to estimate the gross effect of time on transport costs. We include the distance and road quality in the regression. Note that this road quality may not be limited to the channels of fuel and labor costs, and it may also affect toll, fines, and meals and lodging costs that are also included in the reported transport costs if the distance is given. The results indicate that both distance and road quality are statistically significant at 1%, implying they are very important for transportation costs.

First, the coefficient for total costs is 0.87, slightly lower than 1, which might result from the scale effects.

Second, the coefficient for the variable of speed is -.007, which implies that goof road quality could significantly decrease the transportation costs. Specifically, if the speed increases by 1 km per hour, the total direct transportation costs could be reduced by 0.7%. As aforementioned, if the distance is given, bad road quality could significantly increase the transportation time, which would increase fuel costs, labor costs, and the loss of agricultural products due to perishment. On the contrary, the results support that traders do benefit from the improvement of infrastructure investment in China.

5 Conclusion and implications

With unique data set on the traders of agricultural goods in China, this study provides direct evidence on the transport costs and their determinants within China. We find that transport cost accounts for over 40% of the trade costs. Among the components of transport costs, about half are fixed costs, in which more than 60% are incurred by the government taxes such as registration fees and road use fees. In the rest half of variable costs, most important parts are the direct costs of labor and fuel contributes, both of which contribute more than 45% of variable costs in the observed samples. The artificial barriers created by tolls and fines are also substantial, but less important than fuel and labor costs.

We further estimated the determinants of transport costs. We find that the quality of infrastructure approximated by the transport speed is a significant factor of transport costs. Given the distance, if increasing transport speed by 1 km per hour now, the fuel costs and total direct transportation costs would reduce by 1.3% and 0.7% respectively. This happens through two channels: increasing fuel-burning efficiency and reduce the demand for labor. However, the labor costs are only positively correlated with transportation time while the effect of road quality is not significant for labor costs.

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Table 1 Trade Barriers and Transportation Costs

	Full Sample		*Contracted Transport*		*Self-Transport*		*Mixed Transport*	
	%	S.D.	%	S.D.	%	S.D.	%	S.D.
Markup Rate	25.66	19.82	27.61	20.32	20.84	18.74	19.73	14.45
Profit Rate	7.48	7.57	7.63	7.76	7.24	7.52	6.58	5.81
Trade Barriers	18.18	16.14	19.98	16.72	13.60	13.96	13.15	12.72
Weight of Trans. In Trade Barriers	42.05	28.66	44.50	28.58	35.01	29.48	37.49	24.40
Fixed Transport Costs Rate					51.81	40.92	14.65	23.08
Variable Transport Costs Rate					48.19	40.92	31.20	36.89
No. of observations	224		162		46		16	

Table 2 Decomposition of Fixed Transportation Costs

	Self-Transport		*Mixed Transport*	
	%	S.D.	%	S.D.
Maintenance Costs	14.23	17.67	9.78	9.50
Insurance	3.83	5.58	1.95	2.28
Taxes	64.19	29.65	68.70	27.59
Other Fixed Costs	17.76	17.58	19.56	19.63
No. of observations	34		10	

Table 3 Decomposition of Variable Transportation Costs

	All Means of Transportation			*Truck Transportation*		
	%	S.D.	No. of Obs.	%	S.D.	No. of Obs.
Fuel Cost	47.87	32.39	58	45.14	28.39	25
Labor Cost	45.12	93.15	40	44.66	40.11	17
Toll	18.27	20.04	46	14.52	14.59	17
Fines	16.42	51.70	31	5.05	8.13	9
Other Costs	7.03	15.98	31	16.05	27.72	8

Table 4 Estimation of the Determinants of Transportation Costs

	ln(Fuel)		*Labor*		*ln(Total cost)*	
	FE	Heckit	FE	Heckit	FE	Heckit
Female	0.00	0.18	56.46	114.82	-0.02	-0.01
	(-0.02)	(0.50)	(0.37)	(0.68)	(-0.10)	(-0.05)
Education	-0.13	-0.06	-12.97	59.11	-0.03	-0.01
	(-1.61)	(-0.57)	(-0.23)	(0.64)	(-0.40)	(-0.14)
Age	0.00	-0.02	13.22	12.07	0.01	0.01
	(0.07)	(-0.34)	(1.92) *	(1.57)	(0.96)	(0.78)
ln (Distance)	1.13	1.14			0.87	0.91
	(12.19)***	(12.75) ***			(16.46) ***	(17.85) ***
Time/Distance	-0.01	-0.02	0.51	-3.88	-0.01	-0.01
	(-1.81) *	(-2.95) ***	(0.12)	(-1.19)	(-2.19) **	(-2.71) ***
Time			23.07	24.83		
			(8.52) ***	(13.28) ***		
Intercept	0.11	-2.29	-262.03	-1572.09	1.52	0.81
	(0.15)	(-0.46)	(-0.58)	(-0.77)	(2.74) ***	(0.54)
Mills		1.55		586.03		0.43
		(0.45)		(0.70)		(0.29)
F-tests for Fixed-Effects	F(6, 59) =1.69		F(4, 40)=1.81		F(8, 196)= 2.33	
No. of Obs.	71		50		210	

Note: (1) The variables included in the selection functions are Female, education, age, age squared, marriage, and dummy of Beijing.
(2) ***, ** and * denote the significant level of 1%, 5% and 10%, respectively.
(3) t-ratios are reported in ().