

# A test of the Alchian–Allen conjecture with transaction-level trade data

Jieun Choi<sup>a</sup>, Asier Minondo<sup>b</sup>

<sup>a</sup>The World Bank, 1818 H St NW, Washington, DC 20433, United States.; <sup>b</sup>Deusto Business School, University of Deusto, Camino de Mundaiz 50, 20012 Donostia - San Sebastián, Spain. Reserch affiliate of Instituto Complutense de Estudios Internacionales

## ARTICLE HISTORY

Compiled June 18, 2018

## ABSTRACT

We use Kosovo’s transaction-level import value, tariff duties and transport cost data for very finely-disaggregated products to test the Alchian–Allen conjecture. First, we show that the elasticity of freight costs to import prices is much lower than the unitary elasticity predicted by the iceberg transport cost hypothesis. Second, we find that import unit values rise with transport costs and decline with ad valorem tariffs. Our results confirm the Alchian–Allen conjecture that per-unit transport costs reduce the price of high-quality varieties relative to low-quality varieties, raising their relative demand in high freight cost destinations.

## KEYWORDS

Alchian–Allen conjecture; transaction-level data; Kosovo; iceberg transport costs.

## JEL CLASSIFICATION

F02,F10,

## 1. Introduction

Alchian and Allen (1964) conjectured that if transport costs had a per-unit component, sales of high-quality varieties would be larger in more distant destinations. This paper tests the validity of this conjecture using Kosovo’s transaction-level import price, tariff duties, and freight data for highly disaggregated product categories and finely defined origins and destinations.

Our regression analyses support the Alchian–Allen conjecture. First, we confirm that transport costs have a large per-unit component. We show that the elasticity of freight costs with respect to prices is much lower than the unitary elasticity predicted by the iceberg transport cost hypothesis. Second, we find a positive association between the quality of the products imported by Kosovo and the freight cost. In contrast, the quality of imported products declines with ad valorem tariffs.

The contribution of this paper is to test the Alchian–Allen conjecture with the most disaggregated shipment observations and a specification that controls for idiosyncratic origin-product-year and destination-product-year effects. Previous papers have tested

---

Corresponding author: Asier Minondo (aminondo@deusto.es)

the Alchian–Allen conjecture using observations that aggregated thousands of transactions’ import values and freight costs at broad product classifications (Hummels and Skiba 2004; Lugovskyy and Skiba 2015; Miljkovic 2018).<sup>1</sup> This type of data may lead to a simultaneity problem. First, freight costs are partly determined by the price of products, since high prices lead to greater insurance and handling costs. Second, due to the Alchian-Allen effect, firms will export the high-quality (high-price) products to destinations with greater freight costs. If we aggregate many transactions for a broadly defined product into a single observation, the (average) price corresponding to each observation will capture the specialization of exporters into high-quality products when selling to high-freight-cost destinations. We neutralize the simultaneity problem using observations that measure the freight cost and the import price at the transaction level at very finely disaggregated product categories. At this measurement level, there is no heterogeneity in quality within the observation. Furthermore, our database allows us to control for the transaction’s city of origin and destination. This allows a very precise estimation of the association between import prices and freight costs. We show that the use of transaction-level data instead of aggregated data leads to sizable differences in the estimated elasticities.<sup>2</sup>

## 2. Data

Our database covers the universe of Kosovo’s import transactions for the 2013–2017 period. For each transaction, we knew the imported product’s Harmonized System 10-digit classification, the country of origin of the imported product, the exporting country, the invoice value of the transaction net of freight or other trade costs, the freight cost, the tariff duty, the incoterm that rules the transaction, and the location of the incoterm. To ensure that our data captured the whole freight cost from origin to destination, we selected the observations where the country of origin of the product was the same as the exporting country. For a precise location of the origin of the transaction we selected the observations that identified the location of the incoterm at the city level. We removed observations without freight costs and with invoice values below 1,500 euros. After the cleaning process, our sample contained 382,253 transactions, which represented 11% of the original 3,497,116 import transactions, and covered 43% of the total value of imports during the 2013–2017 period. The average freight cost over import value was 7%. This percentage is the same as that calculated by Wolanski (2017) with Chilean import shipments.

## 3. Regression analyses

The Alchian–Allen effect arises because there is a per-unit component in freight costs. On the contrary, the iceberg hypothesis contends that transport costs only depend on the price of the goods that are shipped. To determine which hypothesis is borne by data, we estimate the following regression equation

---

<sup>1</sup>Other papers have tested the empirical validity of the Alchian–Allen conjecture in other markets, such as tickets for football games (Bertonazzi, Maloney, and McCormick 1993), gasoline (Lawson, Raymer et al. 2006) and marijuana (Lawson and Nesbit 2013). There is also a large body of literature that has addressed the theoretical validity of the Alchian–Allen conjecture (see Miljkovic (2018) for a recent summary).

<sup>2</sup>Our paper is closer to Wolanski (2017), who uses shipment-level import data to analyze the relationship between trade-related insurance costs and distance.

$$\ln f_{dokti} = \beta_1 \ln p_{dokti} + \beta_2 \ln w_{dokti} + \beta_3 \ln dist_{do} + \gamma_{dkti} + \gamma_{okti} + \epsilon_{dokti} \quad (1)$$

where  $f_{dokti}$  is the transaction-level per-kilogram freight rate of product  $k$  imported by Kosovan city  $d$  from foreign city  $o$  at year  $t$  with incoterm  $i$ ;<sup>3</sup>  $p_{dokti}$  is the per-kilogram import price,  $w_{dokti}$  the weight of the transaction, and  $dist_{do}$  the distance between city  $d$  and city  $o$ . Equation (1) includes a destination-product-year-incoterm fixed effect and an origin-product-year-incoterm fixed effect. These multidimensional fixed effects allow us to control for all variables specific to an origin, product, year, and incoterm, and all variables that are specific to a destination, product, year and incoterm. Their inclusion in (1) enables a very precise estimation on how the variation in unit freight costs is associated with the variation in unit import prices.  $\epsilon_{dokti}$  is the disturbance term. If the iceberg hypothesis was correct, we would expect a  $\beta_1$  coefficient equal to 1; whereas, if the Alchian–Allen hypothesis was right, we would expect a  $\beta_1$  coefficient less than one. We cluster standard errors by city of origin and city of destination.

Column (1) of Table 1-column (1) presents the estimation results.<sup>4</sup> The elasticity of freight costs with regard to the import price is positive: 0.578. However, the coefficient is much lower than the unitary elasticity predicted by the iceberg transport cost hypothesis. This result confirms that transport costs have a large per-unit component. As expected, the per-kilogram freight cost rises with the distance between origin and destination. It is noteworthy that the absolute value of the per-kilogram freight cost elasticity, 0.192, is much lower than the average elasticity of trade value with regard to the distance identified in Disdier and Head’s (2008) meta-analysis, 0.9. This difference, as pointed out by Head and Mayer (2013), suggests that other variables, in addition to trade costs, contribute to the negative relationship between trade value and distance. The per-kilogram freight cost declines as the kilograms delivered in the transaction increase. This result suggests that transport costs have a fixed cost component.

In order to compare how transaction-level data and an estimation with multidimensional fixed effects improve on previous tests of the Alchian–Allen conjecture based on aggregated data, we re-estimate Hummels and Skiba’s (2004) equation (10) as follows

$$\ln f_{jkt} - \overline{\ln f_{kt}} = \beta_0 + \beta_1(\ln p_{jkt} - \overline{\ln p_{kt}}) + \beta_2(\ln w_{jkt} - \overline{\ln w_{kt}}) + \beta_3(\ln dist_{jk} - \overline{\ln dist_k}) + (\epsilon_{jkt} - \epsilon_{kt}) \quad (2)$$

Compared to (1), all variables are product and year demeaned, and observations are at the exporter-country and importer-country level rather than at the city of origin, city of destination, and incoterm levels.<sup>5</sup> To estimate (2), we collapse our data at the exporter country, importer country, product, and year level.<sup>6</sup>

---

<sup>3</sup>City  $d$  is one of the sixteen of Kosovan customs offices where the transaction is cleared. We calculate origin-destination specific geodesic distances. Latitude and longitude data are obtained using the `opencagegeo` geocoding Stata module.

<sup>4</sup>Note that some observations are dropped from the sample because there is no variation within some of the high-dimensional fixed effects.

<sup>5</sup>Since the country of destination is always Kosovo, we only include an exporting country ( $j$ ) subscript in the equation.

<sup>6</sup>We calculate geodesic distances using the capital cities’ latitude and longitude from CEPII’s `GeoDist` database (Mayer and Zignano 2011).

Column (2) of Table 1 presents the results of estimation. The elasticity of freight with respect to import prices is 0.661. The value of this coefficient is 14% higher than the one reported in column (1). This result indicates that using transaction-level freight and import value data and introducing controls for origin, destination, product, year, and incoterms leads to a non-negligible reduction in the elasticity of freight costs with respect to import price. We also observe an increase in the absolute value of the distance coefficient and the weight coefficient. Compared to the estimates reported by Hummels and Skiba (2004) for US imports (Table 1-OLS estimation), our price elasticity is 7% lower, distance elasticity is 114% larger, and weight elasticity is 44% lower.

If transport costs had a unitary component, the sales of the high-quality variety relative to the low-quality variety would increase with freight costs. To test this conjecture, we estimate the following equation

$$\ln p_{dokti} = \beta_1 \ln f_{dokti} + \beta_2 \ln r_{jkt} + \gamma_{dkti} + \gamma_{okti} + \epsilon_{dokti} \quad (3)$$

where  $r_{jkt}$  is the ad valorem tariff that Kosovo imposes on  $k$  products imported from country  $j$  in year  $t$ .

Column (1) of Table 2 presents the results of the estimation. In line with the Alchian–Allen conjecture, there is a positive association between the freight rates and the quality of the imported product, proxy by the unitary import price. As predicted by Hummels and Skiba (2004), the tariff coefficient is negative, since the ad valorem nature of this variable dampens the positive effect of the per-unit transport cost element.

As in the previous analysis, we compare how estimations change when we aggregate our data to the level used by previous empirical studies. Following, Hummels and Skiba (2004), we estimate

$$\ln p_{jkt} - \overline{\ln p_{kt}} = \beta_0 + \beta_1 (\ln f_{jkt} - \overline{\ln f_{kt}}) + \beta_2 (\ln r_{jkt} - \overline{\ln r_{kt}}) + \beta_3 (\ln GDPpc_{jt} - \overline{\ln GDPpc_{kt}}) + (\epsilon_{jkt} - \epsilon_{kt}) \quad (4)$$

Equation (4) includes the GDP per capita of the exporting country to control for the fact that high-income countries produce higher quality goods (Schott 2004; Hummels and Klenow 2005). We find a 69% increase in the elasticity of quality with respect to freight costs (Column (2) of Table 2). The tariff coefficient is reduced by 17%, and GDP per capita is not statistically significant.<sup>7</sup>

## 4. Conclusions

Using transaction-level import price, customs duty, and freight cost data and estimating a specification that controls for origin, destination, product, incoterm code, and time effects, this paper provides evidence in favor of the Alchian–Allen conjecture. First, we show that transport costs have a per-unit component. Instead of the unitary elasticity predicted by the iceberg transport cost hypothesis, we find that a 10% increase in the price of the product raises freight costs by only 5.8%. Second, we find

---

<sup>7</sup>We cannot compare our results with Hummels and Skiba (2004) because they report estimates based on the multi-country sample and a specification with instrumental variables (Table 2 in their paper).

that a 10% increase in freight cost leads to a 4.4% rise in the unit price of imports; whereas, a 10% increase in tariffs leads to a 32% decline in the unit price of imports.

## Acknowledgements

Findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, nor those of the Executive Directors of the World Bank or the governments they represent. We thank Kosovo's Customs for providing us with the essential information to carry out the empirical analyses. Asier Minondo gratefully acknowledges financial support from the Spanish Ministry of Economy and Competitiveness (MINECO ECO2016-79650-P and ECO2015-68057-R, co-financed with FEDER) and the Basque Government Department of Education, Language Policy and Culture (IT885-16).

## References

- Alchian, Armen A, and William R Allen. 1964. *University economics: Elements of inquiry*. California: Wadsworth.
- Bertonazzi, Eric P., Michael T. Maloney, and Robert E. McCormick. 1993. "Some evidence of the Alchian and Allen Theorem: the third law of demand?" *Economic Inquiry* 31 (3): 383–393. <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7295.1993.tb01300.x>.
- Disdier, Anne-Celia, and Keith Head. 2008. "The Puzzling Persistence of the Distance Effect on Bilateral Trade." *The Review of Economics and Statistics* 90 (1): 37–48. <https://doi.org/10.1162/rest.90.1.37>.
- Head, Keith, and Thierry Mayer. 2013. "What separates us? Sources of resistance to globalization." *Canadian Journal of Economics/Revue canadienne d'économique* 46 (4): 1196–1231.
- Hummels, David, and Peter J Klenow. 2005. "The variety and quality of a nation's exports." *American Economic Review* 95 (3): 704–723.
- Hummels, David, and Alexandre Skiba. 2004. "Shipping the good apples out? An empirical confirmation of the Alchian-Allen conjecture." *Journal of Political Economy* 112 (6): 1384–1402.
- Lawson, Robert, Lauren Raymer, et al. 2006. "Testing the Alchian-Allen theorem: A study of consumer behavior in the gasoline market." *Economics Bulletin* 4 (35): 1–6.
- Lawson, Robert A, and Todd M Nesbit. 2013. "Alchian and Allen revisited: Law enforcement and the price of weed." *Atlantic Economic Journal* 41 (4): 363–370.
- Lugovskyy, Volodymyr, and Alexandre Skiba. 2015. "How geography affects quality." *Journal of Development Economics* 115 (July): 156 – 180. <http://www.sciencedirect.com/science/article/pii/S0304387815000073>.
- Mayer, Thierry, and S Zignano. 2011. "Notes on CEPIIs distances measures: the GeoDist Database." *CEPII Working Paper 2011-25* .
- Miljkovic, Dragan. 2018. "Transportation costs and trade for differentiated agricultural products." In *Handbook of International Trade and Transportation*, edited by Bruce A. Blonigen and Wesley W. Wilson. Edward Elgar Publishing.
- Schott, Peter K. 2004. "Across-product versus within-product specialization in international trade." *The Quarterly Journal of Economics* 119 (2): 647–678.
- Wolanski, Adrian. 2017. "The role of insurance in international shipping costs." *Economics Letters* 155: 116–120. <http://www.sciencedirect.com/science/article/pii/S0165176517301271>.

**Table 1.** Transport costs are not ad valorem

	(1)	(2)
	Transaction	Aggregated
Import price (log)	0.578*** (0.017)	0.661*** (0.023)
Distance (log)	0.192** (0.091)	0.244*** (0.043)
Weight (log)	-0.104*** (0.012)	-0.123*** (0.010)
N. observations	326513	55432
Adj. R-squared	0.954	0.645

Note: Standard errors in parentheses. In equation (1), they are clustered by origin and destination; in equation (2), by exporting country. \*\*\*, \*\*, \* statistically significant at 1%, 5%, and 10%, respectively.

**Table 2.** The validity of the Alchian–Allen conjecture

	(1)	(2)
	Transaction	Aggregated
Freight cost (log)	0.440*** (0.022)	0.744*** (0.022)
Tariff (log)	-3.203*** (0.424)	-2.663*** (0.315)
GDPpc exporter (log)		-0.021 (0.070)
N. observations	326513	55432
Adj. R-squared	0.979	0.565

Note: Standard errors in parentheses. In equation (1) they are clustered by origin and destination; in equation (2), by exporting country. \*\*\*, \*\*, \* statistically significant at 1%, 5%, and 10%, respectively.