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Examining the distance puzzle in the global coffee trade

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Abstract
We examine whether the impact of transportation costs originating from physical distance in the global coffee trade does not decrease over time (i.e., "the distance puzzle") by applying a gravity model from 2009 to 2019. We account for contiguous borders due to their direct impact on transportation costs. We also examine the effect of cultural distance stemming from colonial dependency, common colonizer, and common language. Our results reveal that transportation costs are initially stable but show a negative trend in the long run, particularly post-2015. Moreover, contiguous borders have a significantly positive impact on the coffee trade. Finally, colonial dependency and common colonizers (common language) significantly increased (decreased) the coffee trade.

Keywords: gravity model, coffee trade, transportation costs, distance
JEL Classification Codes: C51, F14, Q17

1. Introduction

Coffee has been consumed for over a thousand years and is currently one of the most consumed beverages in the world and the second-largest traded commodity after petroleum worldwide (Mussatto *et al*., 2011). The world has become flatter due to globalization (Yotov, 2012). Therefore, transportation costs are declining due to the rapid growth in trade and technological advances (Hummels, 2007; Yotov, 2012). However, Disdier and Head (2008) found that although the negative effect of physical distance on trade decreased slightly during 1870-1950, it began to rise afterward, referred to as "the distance puzzle".

The contribution of this study is that it examines the distance puzzle in global coffee trade for 2009-2019 using the gravity model, as the literature on international coffee trade has remained silent regarding globalization and the diminishing effects of physical distance. We

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also account for contiguous borders, as they facilitate simpler and more cost-effective land-based transportation routes. In addition, we investigate the impact of cultural distance stemming from colonial dependency, common colonizer, and common language. The only study that investigates the global coffee trade is Abafita and Tadesse (2021) for 2001–2015, but it does not consider the distance puzzle. Understanding how transportation costs evolved over the years provides insights into the efficiency of coffee trade networks. This is important as it enables exporters and importers to make informed decisions about their trade and market strategies. Therefore, producers and policymakers can optimize logistical processes, reduce trade barriers, and enhance the effectiveness of the coffee trade.

The paper is organized as follows. Section 2 shows the methodology. Section 3 presents and discusses the empirical results and section 4 concludes.

2. Data and methods

The study of Anderson and van Wincoop (2003) provides the standard gravity system as follows:

$$X_{ij} = \frac{Y_j Y_i}{Y}\left(\frac{t_{ij}}{P_j \Pi_i}\right)^{1-\sigma} \tag{1}$$

$$\Pi_i^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \frac{Y_j}{Y} \tag{2}$$

$$P_j^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma} \frac{Y_i}{Y} \tag{3}$$

where X_{ij} represents the international bilateral trade flows from country i to destination j with $i \neq j$; Y_i (Y_j) represents the economic size of the i (j) country; Y is the world output; t_{ij} is the trade cost factor that incorporates bilateral trade cost variables (i and j); Π_i (P_j) is the outward (inward) multilateral resistance that captures the fact that exports (imports) from (into) country i to (from) country j depend on trade costs across all export markets (suppliers); σ is the elasticity of substitution between all goods. In our analysis, we measure coffee trade flows between countries i and j using trade values, expressed in thousands of current United States dollars. Furthermore, the trade cost factor incorporates the transportation cost variables, such as the physical distance between countries i and j and whether they share contiguous borders. It also considers cultural distance variables, including colonial dependency, colonial ties, and the common language spoken between countries i and j.

Our gravity model accounts for the multilateral resistances by including exporter-time and importer-time fixed effects (Yotov *et al.*, 2016).[1] Following Yotov (2012), we estimate our model with a Poisson Pseudo-Maximum Likelihood (PPML) regression for the time interval $t \in [2009, 2019]$ as follows:

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[1] We exclude exporter (importer) variables, such as the economic size of the county i (j), from our model due to their perfect collinearity with the exporter-time (importer-time) fixed effects. This is also evident in the studies of Silva and Tenreyro (2006) and Yotov et al. (2012), among others, which incorporate exporter-time and importer-time fixed effects in their gravity models.

$$X_{ijt} = exp\left[a_0 + \sum_{t=09}^{t=19} a_{1t} lnd_{ij} + a_2 cb_{ij} + a_3 cd_{ij} + a_4 cc_{ij} + a_5 cl_{ij} + \eta_{it} + \theta_{jt}\right] + u_{ijt} \quad (4)$$

where: d_{ij} represents the physical distance (km) between the most populated city of countries i and j; cb_{ij}, cd_{ij}, cc_{ij}, and cl_{ij} are binary variables that take the value of one if countries i and j share contiguous borders (cb_{ij}), are in a colonial/dependency relationship (cd_{ij}), share a common colonizer post-1945 (cc_{ij}), or share a common official or primary language (cl_{ij}); η_{it} and θ_{jt} represent the vector of exporter-time and importer-time fixed effects to account for the outward and inward multilateral resistances; a_0, a_{1t}, a_2, a_3, a_4, and a_5 are the coefficient parameters to be estimated; u_{ijt} is the independent and identically distributed error term. We cluster standard errors based on trading pairs to address intra-cluster correlations (Yotov *et al.*, 2016).

Silva and Tenreyro (2006) advocate for the use of PPML regression over the ordinary least squares log-log regression for gravity models since it provides more robust and consistent estimates. For our analysis, we derive coffee trade flow data, along with variables such as physical distance, colonial dependency, common colonizer, and common language, from the CEPII gravity database. This dataset was developed as part of the MATS European Union project (https://sustainable-agri-trade.eu) and is publicly accessible (Rezitis *et al.*, 2024). To construct the contiguous border variable, we use a dataset from GeoDataSource (https://www.geodatasource.com) that lists countries and their respective land border neighbors. Our data spans from 2009 until 2019, reflecting all the coffee trade flows (not roasted or decaffeinated, decaffeinated and not roasted, roasted and not decaffeinated, roasted and decaffeinated, husks and skins) for 227 countries (different sovereign degrees).

We test whether the effects of transportation costs originating from physical distance on the coffee trade are increasing or decreasing in the long run, i.e., whether the distance puzzle exists. Finally, we perform the Ramsey (1969) test to check whether our model is correctly specified.

3. Results

Based on the empirical results (Table 1), our model shows high goodness of fit statistic by its pseudo-R^2 value of 84.42% and passes the Ramsey (1969) test.[2] The year 2015 shows that transportation costs have the highest negative effect on the coffee trade, equal to -0.709%, followed by the year 2009 (-0.706%) and the year 2012 (-0.702%). The 2019 year has the lowest negative effect on transportation costs, equal to -0.623%. In addition, countries with contiguous borders experienced, on average, a 0.967% higher coffee trade during the examined period. Shared borders facilitate smoother logistics and foster stronger economic and trade relationships. The blue line in Figure 1 illustrates the distance coefficients presented in Table 1.

Regarding the cultural distance variables, the colonial dependency between countries increased the coffee trade by 5.189% on average, possibly because colonial powers established trade routes that facilitated the coffee trade. Additionally, trade flows increase by 1.654% on average if two countries share a common colonizer. Colonial powers often build trade networks

[2] Our analysis refers to 5% as the significance level unless stated otherwise.

that newly independent nations continue to exploit. Interestingly, we find that countries sharing a common language have 0.296% lower coffee trade, significant at the 10% level. This suggests that more coffee trade occurs between countries with different linguistic backgrounds. We attribute this finding to the fact that many top coffee-producing countries, particularly in Latin America, share a common language and often compete in the coffee market. As a result, they prioritize exports to non-coffee-producing countries with diverse linguistic profiles. Abafita and Tadesse (2021) also find that only colonial dependencies and common colonizers increase the coffee trade but to a lesser extent. However, while previous studies have identified a positive impact of a common language on coffee trade, our findings suggest the opposite. This indicates that shared languages may reflect competition among coffee-producing nations rather than facilitating trade. Similarly, for other agricultural products, Davis (2014) finds that a common language between countries reduces turkey imports.

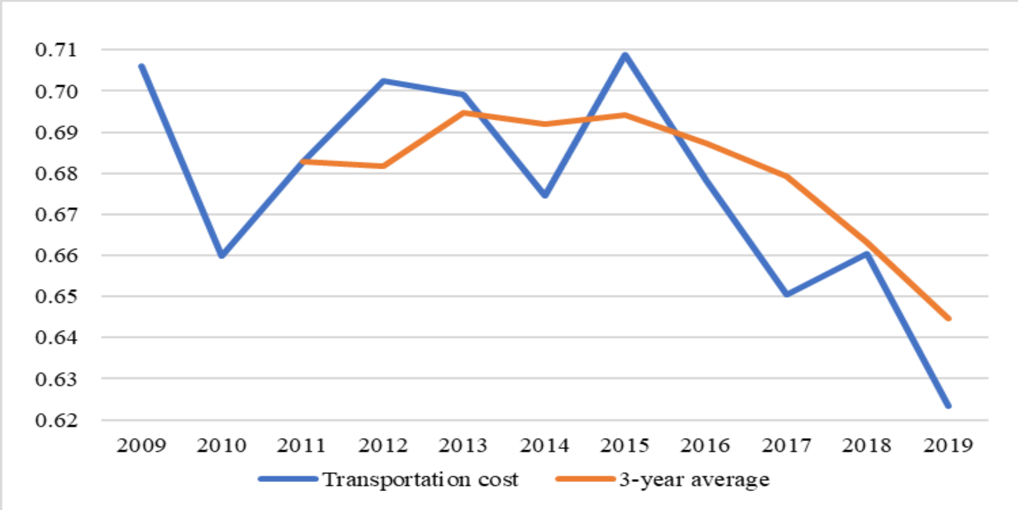
Table 1. Gravity model estimates

Variable name	Estimate	R.S.E.
Constant	16.268	0.595
Physical distance		
2009.distance	-0.706***	0.089
2010.distance	-0.660***	0.084
2011.distance	-0.683***	0.077
2012.distance	-0.702***	0.077
2013.distance	-0.699***	0.072
2014.distance	-0.675***	0.080
2015.distance	-0.709***	0.072
2016.distance	-0.678***	0.070
2017.distance	-0.651***	0.068
2018.distance	-0.660***	0.069
2019.distance	-0.623***	0.067
Contiguous borders	0.967***	0.191
Cultural distance		
Colonial dependency	5.189***	0.977
Common colonizer	1.654***	0.230
Common language	-0.296*	0.163
(Pseudo) R^2	84.42%	
Observations	62919	
Wald X^2	445.43	
Ramsey test	0.558	

Source: own elaboration
Notes: Symbol *** (**) (*) denotes the 1% (5%) (10%) significance level.
The column R.S.E. denotes the robust standard errors.

Table 2 shows the percentage changes in the effect of transportation costs on coffee trade over the years. We calculate the percentage changes by taking the difference of the estimated coefficients of the gravity model (Table 1) over the years and multiplying it by 100. To determine the direction of the effect of transportation costs on coffee trade, we multiply the calculated values by −1. Negative values show a decreasing impact of transportation costs on trade and vice versa. Furthermore, we perform a Wald test statistic on the calculated percentage change values of Table 2, and the estimated p-values are given in parenthesis below each computed value, showing the statistical significance of the calculated percentage changes.

Figure 1. Global coffee transportation cost effects 2009-2019



Source: own elaboration

The effect of transportation costs on coffee trade (Table 2) dropped by 4.621% during 2009-2010. However, the impact of transportation costs shows no significant change during 2010-2015. Several important events led to the above result. First, in 2011, supplies ran low due to heavy rain, leading to worse harvests in Colombia, Indonesia, Mexico, and Vietnam (top coffee exporters), resulting in the highest coffee prices in over 34 years.[3] Second, the sluggish growth in developed economies and the uncertainty over the euro during 2011-2013 contributed to the deceleration of trade (WTO, 2013). Third, in 2014, the Brazilian drought wiped out a third of Brazil's (top coffee exporter) coffee crops in some areas, leading to a rise in the price of coffee arabica.[4] Fourth, trade decreased during 2014-2015 mainly due to an economic slowdown in China and a severe recession in Brazil, which reduced Brazil's export earnings (WTO, 2016). During an economic downturn, demand for tradable goods such as coffee often decreases, reducing the production of these goods. Thus, there has been no significant change in the impact of transportation costs on the coffee trade during 2010-2015, which might result from two opposite causes. The first one is the negative effect of technological change on transportation costs. The second one is the positive effect of the abovementioned (four) events that decreased global coffee production and trade, increasing transportation costs as it spread over fewer trading units.

The transportation cost effect dropped by 5.826% and 8.558% during 2015-2017 and 2015-

[3] Source: https://www.theguardian.com/business/2011/apr/21/commodities-coffee-shortage-price-rise-expected
[4] Source: https://www.theguardian.com/world/2014/feb/25/brazil-drought-threatens-coffee-crops

2019, respectively. It also dropped by 3.059% and 4.842% during 2015-2016 and 2015-2018 at the 10% significance level. The above results suggest that coffee trade transportation costs decreased after 2015. Additionally, there is a decrease in the transportation cost effect during 2013-2019 (7.585%) at the 10% significance level. Therefore, the impact of transportation costs decreases in the long run, especially for the post-2015 period. Finally, the effect of transportation costs decreased by 3.715% during 20018-2019. The orange line in Figure 1 shows the 3-year average of the transportation trade cost effects and that the effect decreases in the long run.

Table 2. Percentage change of the effect of transportation cost on global coffee trade

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2010	-4.621									
	(0.008)									
2011	-2.340	2.281								
	(0.551)	(0.429)								
2012	-0.368	4.253	1.972							
	(0.942)	(0.314)	(0.407)							
2013	-0.698	3.923	1.643	-0.330						
	(0.889)	(0.352)	(0.572)	(0.888)						
2014	-3.153	1.468	-0.813	-2.785	-2.456					
	(0.347)	(0.619)	(0.823)	(0.477)	(0.467)					
2015	0.275	4.896	2.615	0.643	0.973	3.428				
	(0.949)	(0.177)	(0.439)	(0.859)	(0.749)	(0.134)				
2016	-2.784	1.837	-0.444	-2.416	-2.086	0.369	-3.059			
	(0.535)	(0.629)	(0.902)	(0.506)	(0.492)	(0.878)	(0.084)			
2017	-5.551	-0.930	-3.211	-5.183	-4.853	-2.398	-5.826	-2.767		
	(0.252)	(0.822)	(0.364)	(0.165)	(0.116)	(0.465)	(0.010)	(0.165)		
2018	-4.567	0.054	-2.227	-4.199	-3.869	-1.414	-4.842	-1.783	0.984	
	(0.374)	(0.990)	(0.561)	(0.314)	(0.265)	(0.705)	(0.074)	(0.500)	(0.491)	
2019	-8.283	-3.661	-5.942	-7.915	-7.585	-5.129	-8.558	-5.498	-2.732	-3.715
	(0.164)	(0.494)	(0.192)	(0.101)	(0.073)	(0.277)	(0.012)	(0.114)	(0.236)	(0.031)

Source: own elaboration

4. Concluding remarks

Our PPML model reveals that the impact of physical distance (i.e., transportation costs) on global coffee trade initially drops during 2009-2010, exhibits stability during 2010-2015, but shows a negative trend in the long run, particularly post-2015. The above result suggests that the distance puzzle is not evident in our PPML model. Our model also shows the positive impact of contiguous borders on coffee trade. Regarding cultural distance, our findings indicate that colonial dependency and common colonizers increased the coffee trade, emphasizing the lasting influence of colonial history. Conversely, a common language was found to decrease coffee trade, suggesting that top coffee-producing countries tend to prioritize exports to countries with different linguistic backgrounds.

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References

Abafita, J. and Tadesse, T. (2021) Determinants of global coffee trade: Do RTAs matter? Gravity model analysis, *Cogent Economics & Finance,* 9(1), 1892925.

Anderson, J.E. and Van Wincoop, E. (2003) Gravity with gravitas: a solution to the border puzzle, *American Economic Review*, 93(1), 170-192.

Davis, C.G. (2014) What impact does exchange rate volatility have on world turkey trade flows? *World's Poultry Science Journal,* 70(4), 775-786.

Disdier, A.C. and Head, K. (2008) The puzzling persistence of the distance effect on bilateral trade, *The Review of Economics and Statistics*, 90(1), 37-48.

Hummels, D. (2007) Transportation costs and international trade in the second era of globalization, *Journal of Economic Perspectives,* 21(3), 131-154.

Mussatto, S.I., Machado, E.M., Martins, S. and Teixeira, J.A. (2011) Production, composition, and application of coffee and its industrial residues, *Food and Bioprocess Technology,* 4, 661-672.

Ramsey, J.B. (1969) Tests for specification errors in classical linear least-squares regression analysis, *Journal of the Royal Statistical Society Series B: Statistical Methodology,* 31(2), 350-371.

Rezitis, A.N., Karytsas, S., Kyriazi F. and Xylangouras, E. (2024) International data on beef, coffee, pork and poultry products [Data set]. doi:10.5281/zenodo.13862351.

Silva, J.S. and Tenreyro, S. (2006) The log of gravity, *The Review of Economics and Statistics*, 88(4), 641-658.

World Trade Organization (2013, April 10) *Trade to remain subdued in 2013 after sluggish growth in 2012 as European economies continue to struggle* [Press Release], available at https://www.wto.org/english/news_e/pres13_e/pr688_e.pdf

World Trade Organization (2016) *World Trade Statistical Review 2016,* available at https://www.wto.org/english/res_e/statis_e/wts2016_e/wts2016_e.pdf

Yotov, Y.V. (2012) A simple solution to the distance puzzle in international trade*, Economics Letters,* 117(3), 794-798.

Yotov, Y.V., Piermartini, R. and Larch, M. (2016) *An advanced guide to trade policy analysis: The structural gravity model*, WTO iLibrary and UNCTAD.