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Identifying the corrupt cog in the wheel: Dimensions of supply chain logistics and cross-country corruption

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Abstract

Reliable supply chains are crucial to the competitiveness, survival and profitability of businesses. While various aspects of supply chain logistics have been studied, their impacts on corrupt activity have not been fully understood. This paper examines the impact of the different stages of supply chain logistics on corruption. Besides adding insights into channels of potential corruption or rent-seeking, the research identifies potential stages of bureaucratic holdups related to the supply chain and can prove useful in the formulation of a more effective corruption-control policy. We use data for about 150 nations over the period 2000–2018 and the econometric methodology controls for potential reverse feedback from corruption to logistics. Our results show that an improvement in overall logistics performance reduces cross-country corruption, with individual dimensions of logistics having a differential corruption-reducing impact. The main policy implication is that governmental efforts to reduce supply chain bottlenecks will have positive spillovers in terms of reduced corruption.

KEYWORDS

corruption, COVID-19, customs, economic freedom, infrastructure, internet, logistics, shipments, supply chain, timeliness, tracking

JEL CLASSIFICATION

K42; L91; L98

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1 | INTRODUCTION

The empirical literature on the causes (and effects) of corruption has really blossomed in the last decade or two (see Dimant & Tosato, 2018; Goel & Nelson, 2010; Lambsdorff, 2006). Although the issue of corruption has been recognised for a much longer time, the main contributing factor to the spurt in corruption research has been the availability of measures of corruption, mostly at a cross-country level. Researchers have considered numerous factors that affect and are affected by corruption, and some robustness analyses have been able to provide clarity in terms of the significant factors (Serra, 2006). Given the continued worldwide prevalence of corruption, policymakers continue to be interested in recommendations that would effectively enable them to combat the malice of corruption.

The proliferation of corruption research, arguably up to somewhat of a saturation point, has resulted in a situation where more substantive empirical contributions now must either involve novel measures of corruption or include explanatory variables at a finer level of detail. It is with the latter that the present research aims to make a contribution. Using annual panel data on about 150 nations, this paper adds by examining the impact of specific channels of economic freedom related to trade logistics performance and its different dimensions on cross-country corruption.

The performance of logistics dimensions in supply chain performance and reliability are important worldwide but especially challenging for landlocked nations (Arvis, Raballand, & Marteau, 2007; Landesmann & Stöllinger, 2019). Arvis et al. (2018) define logistics as a ‘network of services that support the physical movement of goods, trade across borders, and commerce within borders’ and ‘encompasses an array of activities beyond transportation including warehousing, brokerage, express delivery, and critical infrastructure services such as terminals’ (p. 7). Trade logistics performance is based on several key inputs and outputs in the supply chain delivery and service (see Arvis et al., 2018 for details), where the inputs include customs, infrastructure and services quality, and the outputs include timeliness, international shipments, and tracking and tracing. These different stages of supply chain logistics are examined in terms of their relative impacts on corruption.

The main research questions are:

- What is the impact of improved supply chain logistics performance on cross-country corruption?
- Are the effects of different dimensions of logistics performance on corruption similar?

Besides adding insights into channels of potential corruption or rent-seeking, the research also identifies potential stages of bureaucratic holdups. Insights from answers to the second question will help identify specific avenues of improvements in certain logistics that will bear the greatest returns in terms of corruption reduction.

Viewed from a different angle, logistics bottlenecks might be a channel of transmission of corruption across jurisdictional boundaries. Firms (exporters or importers) in an otherwise non/less-corrupt nation might face logistical constraints and related bribe-demands when trading with other nations. Thus, they would ‘learn’ to be corrupt, and might be more eager to offer bribes in their own country to expedite government procedures. The consideration of different logistics dimensions thus helps us identify possible channels of spatial corruption transmission. In contrast, the contagion or spatial corruption literature has considered (broader) geographic proximity (Becker, Egger, & Seidel, 2009; Goel & Nelson, 2007). Indeed, landlocked (e.g., Nepal)

and small island countries (e.g., Cyprus) face unique challenges given their reliance on the logistics performance of other countries, and these features characterize countries lower ranked in logistics performance (Arvis et al., 2007).

The importance of good logistics performance becomes even more important in the modern globalised world. Indeed, as noted by Arvis et al. (2018), ‘In the current era of globalization, extended supply chains have created more interdependence, and commerce and production have been disrupted by natural events and man-made disasters’ (p. 33). The importance of supply chain reliability is being realised in the current COVID-19 crisis. Relatedly, the presence of corruption in logistics can be viewed as a man-made or artificial disruption.

In addition to the contribution to the literature, it would be useful for policymakers to know where (i.e., which stage of logistics performance) the corrupt cog in the wheel is. If it turns out that only certain, not all, stages of logistics performance affect corruption, then piecemeal reforms would leave room for the bureaucratic hold-up at other stages. This ties to the broader question about how bottlenecks might be unbundled (Höffler & Kranz, 2011). Thus, even after reforms, overall corruption might not decline. The focus on logistics-corruption linkage is especially important during the current COVID-19 times, when supply-chains in many industries are constrained.

Our empirical results show that an improvement in overall logistics performance reduces cross-country corruption. However, not all individual dimensions of logistics have a similar corruption-reducing impact. This is a novel insight with important policy implications. The other influences on cross-national corruption are broadly in line with the larger literature.

The layout of the rest of the paper includes the literature and the model in the next section, followed by data and estimation, results, and conclusions.

2 | THEORETICAL BACKGROUND AND THE MODEL

2.1 | Theoretical background

There are potentially several theoretical streams of the literature that one could tie the current analysis to.

First, the different logistics regulations can be viewed in the context of bureaucratic red tape (see Guriev, 2004) and more generally to the size of the government (Rose-Ackerman, 1999). While logistics involve a business-to-business transaction, its performance depends on government intervention and policies that include such things as regulations (Arvis et al., 2018). More regulations, associated with a large government structure, add to bureaucratic delay given the paperwork (licences) needed to move through various administrative hoops before they are passed or approved (Werlin, 1991). This delay presents opportunities for rent-seeking as some favour seekers are willing to pay bribes to expedite government approvals. While there has been quite a bit of empirical research on the impact of government size on corruption (Goel & Nelson, 1998), the length of bureaucratic red tape is hard to measure and, therefore, empirical investigations of its contribution to corruption are difficult. In fact, operators in countries ranked in the bottom quintile of logistics performance must deal with roughly twice as many governmental agencies and requirements relative to operators in the top quintile (Arvis et al., 2018).

Second, the various logistics stages pose challenges for firms when they are trying to consider vertical integration decisions. Should a manufacturing firm also integrate forward into delivery? While the decisions weighing the costs and benefits of vertical integration have been

well-considered in the industrial organisation literature (Perry, 1989; Schmalensee, 1973), it is not clear whether firms weigh the potential internalisation of corruption/rent-seeking externalities from vertical integration – i.e., whether a vertically-integrated firm would encounter a corrupt bureaucrat less often. This aspect does not seem to have been considered in the extant literature and our stages of logistics provide some insights (albeit with aggregated data).

Third, related to Second above, to the extent the different logistics stages are sequential, one could see how the current analysis might tie as an empirical application of sequential impacts on corruption. For instance, in many cases, the customs interactions might be at the end of the shipments, especially when buyers are collecting the shipments after customs. With sequential stages, the possibility of greater rent-seeking and corruption via bureaucratic holdup might arise.

Fourth, the proliferation of regulations and related rent-seeking opportunities can be viewed in the context of the impact of economic freedom on corruption. The logistics regulations are a more specific form of regulations tied to the transportation sector. In general, greater economic freedom has been shown to lead to lower corruption (Goel & Nelson, 2005; Treisman, 2000), and our analysis will provide insights at a disaggregated level by considering logistics and related dimensions.

Fifth, the consideration of stages of logistics can be tied to the broader research on the impact of government decentralisation on corruption, on which there has been a fair bit of both theoretical and empirical research (Dimant & Tosato, 2018; Goel, Mazhar, Nelson, & Ram, 2017; Goel & Saunoris, 2016). For instance, with regulatory oversight at different stages of logistics, there are more units of the government involved than otherwise. More government units are then generally perceived to be associated with greater transparency, and thereby, with lower corruption.

Sixth, there is a whole body of research on the importance of logistics, without a focus on corruption (Hausman, Lee, & Subramanian, 2005; Nordås, Pinali, & Grosso, 2006). In this line of research, there have been studies focusing on logistical constraints across specific dimensions and specific jurisdictions (Eyob & Kahsai, 2019; Loock, 2013; Tapaninen, Inkinen, & Ruutikainen, 2007). In a study somewhat related to the present, Seabra, Flores, and Gomes (2016) study the effects of corruption and the aggregate logistics performance index on shipping container throughput for Latin American nations.

Seventh, organisation theories provide insights into the distinctions between traditional supply chains and best value supply chains.¹ Some authors, for example, Ketchen and Hult (2007), argue that competition across supply chains might be a new competitive dimension for firms. A lack of supply chain reliability could also act as a barrier to entry of new firms (see Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2002) for a broader discussion; also see Dreher and Gassebner (2013), Goel (2012), Goel, Mazhar, and Saunoris (2020), Goel, Saunoris, and Goel (2020)). While we do not have information on supply chain types per se, our consideration of specific logistics dimensions should capture some of the underlying distinctions.

Finally, it is not clear at which stage of logistics there is greater regulation or oversight. This may be related to less corruption on the one hand, and greater rent-seeking opportunities, on the other hand. Thus, this analysis will somewhat uniquely capture the impacts of lumpiness in regulations.

Overall, we see that the current analysis can be nested in and contributes to several strands of the literature.

2.2 | Model

Based on the above discussion we formulate our main hypothesis that we will test with cross-country data:

Hypothesis 1 *Improvements in logistics performance will reduce corruption, ceteris paribus.*

As argued above, improvements in logistics performance contribute to overall economic freedom, reduce regulatory bottlenecks, and mitigate opportunities for the bureaucratic hold-up. All this would lead to lower corruption, *ceteris paribus*. However, individual dimensions of logistics are qualitatively and administratively different and it is a priori unclear if performance improvements in specific dimensions will yield similar dividends in terms of corruption reduction.

The generic form of the estimated equation to address the main theme of the paper and to test the main hypothesis, takes the following form (with subscript i denoting a country and t a year):

$$\text{Corruption}_{it} (\text{CORR}) = f (\text{Logistics performance}_{itm}, Z_{itg}) \quad (1)$$

$i = 1, \dots, 147$; $t = 2000, \dots, 2018$; $m = \text{Logistics, Timeliness, Tracking, Quality, Shipments, Infrastructure, Customs}$; $g = \text{GDP, PolFREE, GovSize, URBAN, INTERNET}$.

To operationalise Equation (1), we posit a linear relationship between the prevalence of cross-country corruption and a set of determinants, with the main novelty being the inclusion of the logistics performance measures. The other (non-logistics) controls are identified from the literature (Dimant & Tosato, 2018; Goel & Nelson, 2010; Lambsdorff, 2006; Treisman, 2000), and include accounting for economic prosperity (*GDP*), democracy (*PolFREE*), government size (*GovSize*), urbanisation (*URBAN*), and internet usage (*INTERNET*). The intuition behind these determinants is discussed below.

The dependent variable *CORR* is the Corruption Perceptions Index (CPI) from Transparency International. This index measures the perceived level of public corruption by businesses and experts and has been widely used in the extant literature (Goel & Nelson, 2005; Treisman, 2000). While any measure of corruption is inherently imperfect, this index provides a ready comparison of corruption across nations. In our sample, the average value of the index is 55.3 with Afghanistan (CPI score of 92) being the most corrupt country, and Denmark (CPI score of 8) the least corrupt.

The main focus of this work, as mentioned above, is on the influence of logistics performance. Accordingly, the key independent variable is the Logistics Performance Index (LPI – *Logistics*) from The World Bank (both in the aggregate and across its specific dimensions). Broadly speaking, the LPI can be viewed as a specific index of the overall economic freedom. The LPI measure gauges the performance of trade logistics based on six performance indicators including: (1) ‘The efficiency of customs and border management clearance’ (*Customs*); (2) ‘The quality of trade and transport infrastructure’ (*Infrastructure*); (3) ‘The ease of arranging competitively priced shipments’ (*Shipments*); (4) ‘The competence and quality of logistics services—trucking, forwarding, and customers brokerage’ (*Quality*); (5) ‘The ability to track and trace consignments’ (*Tracking*); and (6) ‘The frequency with which shipments reach consignees within scheduled or expected delivery times’ (*Timeliness*).²

These indicators are constructed based on a worldwide survey of operators (i.e., global freight forwarders and express carriers) and their response to the logistics ‘friendliness’ of their country and countries with which they trade. Like the corruption perceptions index, this measure too is based on perceptions of those individuals on the ground (see Arvis et al. (2018) for details). Each subcomponent is measured on a scale from 1 to 5, with higher values denoting

better outcomes. The overall logistics measure (*Logistics*) aggregates the sub-components into a single measure using the Principal Components Analysis. The average level of *Logistics* is 2.95, where Germany (4.23) has the highest logistics performance rating and Burundi (1.61) the lowest.³

In regard to the other factors that impact corruption, we borrow from the extant literature (see Dimant and Tosato (2018), Lambsdorff (2006), Treisman (2000)) and broadly control for economic and political institutions. First, empirical evidence consistently finds lower incidences of corruption in more prosperous countries, likely due to the higher opportunity cost of corrupt acts and improved checks on corruption in higher-income countries. Thus, we include *GDP* to capture the level of prosperity (Serra, 2006; Svensson, 2005; Treisman, 2000).⁴ Furthermore, more urbanised countries are more likely associated with more corruption, likely due to the relative ease of forging corrupt relations. The results in the literature regarding the effect of urbanisation on corruption are mixed (Dimant & Tosato, 2018). Countries with more political rights and civil liberties empower citizens to hold politicians accountable by removing corrupt politicians from office (Goel & Nelson, 2005). Of course, larger governments open up new opportunities for corruption if left unchecked, alternatively, a large government size may mean more resources can be deployed to combat corruption in an effort to maintain trust in government (Goel & Nelson, 1998; Rose-Ackerman, 1999).

Internet prevalence offers another source of control of corruption by exposing corrupt leaders, thus we account for the percent of the population that has internet access (*INTERNET*)—see Andersen, Bentzen, Dalgaard, and Selaya (2011); Goel, Nelson, and Naretta (2012). The role of the internet is especially relevant with regard to logistics, as the performance of certain logistics dimensions, such as timeliness and tracking of shipments, might be affected by the prevalence of the internet. On the other hand, certain logistics dimensions, such as the infrastructure, might be relatively less influenced by the internet.⁵

While the Z controls in Equation (1) have been used in different contexts to explain the drivers of cross-national corruption (see Dimant and Tosato (2018), Lambsdorff (2006), Serra (2006), Treisman (2000)), the focus on logistics and its components in terms of their relative effects on corruption is new.

Next, we turn to a discussion of the data employed and the estimation procedure(s) used.

3 | DATA AND ESTIMATION

3.1 | Data

To test the hypothesis relating logistics performance to corruption, we use a panel data set comprised of 147 countries from 2000 to 2018 – Table 1 includes variable names, definitions, sources, and summary statistics.

The dependent variable, *CORR*, is from Transparency International. This cross-national measure of corruption is widely used in the literature. The logistics measures, the main variables of interest, are from the World Bank (<https://lpi.worldbank.org/>). These indices provide consistent comparisons of logistics performance across its different dimensions for most of the nations in the world.

Table 2 provides correlations between corruption and each logistics measure. The correlation between *CORR* and *Logistics* is -0.793 . Similarly, *CORR* is negatively correlated with each sub-index of *Logistics* with roughly the same correlation coefficient. The main goal of this paper,

TABLE 1 Variable definitions, sources and summary statistics

Variable	Description [observations; mean; standard deviation]	Source
<i>CORR</i>	Corruption perceptions index, measures the perceived levels of public sector corruption according to businesses and experts. The index is on a scale from 0 (highly corrupt) to 100 (very clean); however, the index was rescaled such that higher numbers denote greater corruption. [411; 55.32; 19.88]	Transparency International
<i>Logistics</i>	Overall logistics performance index (LPI), based on Principal Components Analysis of its six sub-indicators (timeliness, tracking and tracing, logistics quality and competence, international shipments, infrastructure, and customs). Higher numbers denote better performance. [411; 2.93; 0.57]	LPI (2018)
<i>Timeliness</i>	Timeliness sub-index of LPI, measures the frequency with which shipments reach a consignee within scheduled or expected delivery times, rated from 1 = 'hardly ever' to 5 = 'nearly always'. [411; 3.31; 0.58]	LPI (2018)
<i>Tracking</i>	Tracking and tracing sub-index of LPI, measures the ability to track and trace consignments, rated from 1 = 'very low' to 5 = 'very high' [411; 2.93; 0.63]	LPI (2018)
<i>Quality</i>	Logistics quality and competence sub-index of LPI, measures the competence and quality of logistics services, rated from 1 = 'very low' to 5 = 'very high'. [411; 2.88; 0.60]	LPI (2018)
<i>Shipments</i>	International shipments sub-index of LPI, measures the ease of arranging competitively priced shipments, rated from 1 = 'very difficult' to 5 = 'very easy'. [411; 2.89; 0.51]	LPI (2018)
<i>Infrastructure</i>	Infrastructure sub-index of LPI, measures the quality of trade and transport infrastructure, rated from 1 = 'very low' to 5 = 'very high'. [411; 2.82; 0.68]	LPI (2018)
<i>Customs</i>	Customs sub-index of LPI, measures the efficiency of customs and border management clearance, rated from 1 = 'very low' to 5 = 'very high'. [411; 2.74; 0.60]	LPI (2018)
<i>GDP</i>	Log of GDP per capita (constant 2010 U.S. dollars). [411; 8.64; 1.53]	The World Bank
<i>PolFREE</i>	Political freedom, measured as the sum of political rights and civil liberties. This index is measured on a scale from 2 to 14, with higher numbers denoting less political freedom. [411; 6.67; 3.84]	Freedom House
<i>GovSize</i>	General government final consumption expenditures as a percent of GDP. [411; 0.16; 0.05]	The World Bank
<i>URBAN</i>	Urban population, measured as a percent of total population. [411; 60.31; 22.14]	The World Bank
<i>INTERNET</i>	Individuals using the internet as a percent of population. [411; 46.61; 29.36]	The World Bank
<i>RAIL</i>	Total rail lines (route-km) per capita. [191; 0.0004; 0.003]	The World Bank

Note: Summary statistics are based on all available data for 147 countries for years 2000 to 2018. LPI: Logistics Performance Index – <https://lpi.worldbank.org/about>. Transparency International – <https://www.transparency.org/>. Freedom House – <https://freedomhouse.org/>.

as alluded to in the title of this paper, is to determine the relative impacts of overall LPI and its components on cross-country corruption.

The other variables are from reputed international sources that are routinely used in the literature (related details are in Table 1).

3.2 | Estimation

To estimate the model, we use a fixed-effects model to purge the unobserved country-specific heterogeneity that is invariant over time, and time effects to account for time-specific events that influence all countries. This consideration accounts for such factors as landlocked nations and island nations that face special logistical challenges (Arvis et al. (2007)). These adjustments enable us to account for influences not otherwise taken into account by the inclusion of other controls in the analysis.

We also employ two-stage efficient GMM estimation to address possible simultaneity between the dependent variable and the different logistics measures. The results section follows.

4 | RESULTS

4.1 | Baseline results

The baseline results, presented in Table 3, aim to test Hypothesis 1 regarding the impact of logistics performance on corruption.

The coefficient on *Logistics* is negative and statistically significant. This is consistent with the notion that, as logistics performance improves the potential for bureaucratic rent-seeking goes down. Whereas the literature has focused on the impact of broad economic freedom on corruption (Goel & Nelson, 2005; Treisman, 2000), this paper provides insights at a finer level of detail by considering logistics performance (both aggregate and its subcomponents). Countries with better logistics performance have, *ceteris paribus*, less corruption. This finding supports Hypothesis 1 outlined above. In terms of elasticity, a 10% increase in the logistics performance index reduces corruption by 1.17%.

Interestingly, however, the dimensions of logistics performance are not created equal in their effects on corruption. Although the coefficients on all the sub-components of *Logistics* are negative, only two of the six are statistically significant. In particular, countries rated higher based on the competence and quality of logistics services (*Quality*), and the ability to track and trace consignments (*Tracking*) prove to be the most effective in curbing corruption.⁶ Indeed, the elasticity measure is similar to that of the overall logistics performance index.

Turning to the control variables, the coefficient on *GDP* is negative and statistically significant across all models, consistent with higher opportunity costs and improved checks and balances that reduce corruption (Serra, 2006).⁷ Political freedom negatively impacts corruption in four of the seven models, consistent with the ability of voters to hold corrupt bureaucrats accountable by voting them out of office. Government size (*GovSize*), urbanisation (*URBAN*), and internet access (*INTERNET*) are negative in their effects on corruption, albeit statistically insignificant. In other words, in our sample, nations with larger governments, greater urbanisation, and more internet access were no different from others.⁸

TABLE 2 Correlation matrix

	CORR	Logistics	Timeliness	Tracking	Quality	Shipments	Infrastructure	Customs
CORR	1							
<i>Logistics</i>	-0.793 [0.000]	1						
<i>Timeliness</i>	-0.722 [0.000]	0.944 [0.000]	1					
<i>Tracking</i>	-0.744 [0.000]	0.969 [0.000]	0.914 [0.000]	1				
<i>Quality</i>	-0.785 [0.000]	0.980 [0.000]	0.909 [0.000]	0.947 [0.000]	1			
<i>Shipments</i>	-0.711 [0.000]	0.948 [0.000]	0.878 [0.000]	0.901 [0.000]	0.913 [0.000]	1		
<i>Infrastructure</i>	-0.796 [0.000]	0.972 [0.000]	0.890 [0.000]	0.930 [0.000]	0.952 [0.000]	0.894 [0.000]	1	
<i>Customs</i>	-0.815 [0.000]	0.957 [0.000]	0.862 [0.000]	0.898 [0.000]	0.936 [0.000]	0.887 [0.000]	0.939 [0.000]	1

Note: See Table 1 for variable definitions. $N = 411$. Probability values are in brackets.

TABLE 3 Corruption and logistics performance: Baseline models, dependent variable: *CORR*

	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)	(3.7)
<i>Logistics</i>	-1.949** (0.828)						
<i>Timeliness</i>		-0.746 (0.494)					
<i>Tracking</i>			-1.373** (0.648)				
<i>Quality</i>				-1.912*** (0.727)			
<i>Shipments</i>					-0.845 (0.569)		
<i>Infrastructure</i>						-1.227 (0.774)	
<i>Customs</i>							-0.872 (0.586)
<i>GDP</i>	-6.972* (3.570)	-7.439** (3.572)	-7.212** (3.518)	-7.089* (3.642)	-7.512** (3.528)	-7.623** (3.452)	-7.627** (3.557)
<i>PolFREE</i>	0.605* (0.324)	0.524 (0.334)	0.571* (0.317)	0.603* (0.311)	0.517 (0.336)	0.552* (0.326)	0.550 (0.337)
<i>GovSize</i>	-3.532 (13.638)	-4.344 (13.367)	-4.477 (13.187)	-4.370 (13.688)	-3.138 (13.640)	-4.407 (13.436)	-4.228 (13.564)
<i>URBAN</i>	-0.063 (0.286)	-0.019 (0.291)	-0.064 (0.291)	-0.012 (0.287)	-0.020 (0.293)	-0.048 (0.286)	-0.012 (0.293)
<i>INTERNET</i>	-0.019 (0.042)	-0.017 (0.042)	-0.024 (0.042)	-0.017 (0.042)	-0.014 (0.042)	-0.014 (0.042)	-0.012 (0.042)
Elasticity							
Related logistics measure	-0.117** (0.050)	-0.050 (0.032)	-0.083** (0.040)	-0.112*** (0.043)	-0.049 (0.033)	-0.072 (0.046)	-0.049 (0.032)
Observations	411	411	411	411	411	411	411
Number of countries	147	147	147	147	147	147	147
Overall R^2	0.695	0.686	0.687	0.705	0.685	0.689	0.695

Note: See Table 1 for variable details. Two-way country- and time fixed effects are accounted for in each model. Robust standard errors are in parentheses. Standard errors of elasticities are based on the delta method. Asterisks denote the significance levels.

* $p < .1$.

** $p < .05$.

*** $p < .01$.

TABLE 4 Corruption and logistics performance: accounting for simultaneity, dependent variable: CORR

	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)	(4.6)	(4.7)
<i>Logistics</i>	-11.279*** (3.693)						
<i>Timeliness</i>		-2.892 (1.774)					
<i>Tracking</i>			-2.861 (3.255)				
<i>Quality</i>				-8.950*** (2.914)			
<i>Shipments</i>					-11.057* (5.711)		
<i>Infrastructure</i>						-5.547** (2.631)	
<i>Customs</i>							-4.999*** (1.439)
<i>GDP</i>	6.657 (6.720)	-2.792 (5.966)	0.087 (6.505)	6.187 (6.361)	18.119 (12.333)	4.997 (6.638)	-0.888 (5.884)
<i>PolFREE</i>	1.363*** (0.494)	0.978** (0.478)	0.930** (0.456)	1.244*** (0.393)	0.762 (0.566)	1.143** (0.469)	1.437*** (0.449)
<i>GovSize</i>	-31.939 (24.976)	-33.383 (23.169)	-32.908 (22.347)	-27.469 (23.195)	-36.683 (29.231)	-24.830 (21.573)	-35.327* (20.934)
<i>URBAN</i>	0.155 (0.377)	0.530 (0.373)	0.416 (0.366)	0.558 (0.348)	0.031 (0.450)	0.174 (0.417)	0.493 (0.346)
<i>INTERNET</i>	-0.112 (0.090)	-0.059 (0.072)	-0.069 (0.100)	-0.068 (0.077)	-0.057 (0.099)	-0.045 (0.062)	-0.012 (0.061)

(Continues)

TABLE 4 (Continued)

	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)	(4.6)	(4.7)
Observations	178	178	178	178	178	178	178
Number of countries	69	69	69	69	69	69	69
Endogeneity test	3.430* [0.064]	0.366 [0.545]	0.066 [0.798]	2.195 [0.138]	2.329 [0.127]	1.064 [0.302]	1.135 [0.287]
Weak identification	5.254	16.34	5.901	6.481	2.299	11.09	7.201
Underidentification	4.160 [0.125]	10.11*** [0.006]	9.516*** [0.009]	7.336** [0.026]	3.951 [0.139]	10.95*** [0.004]	5.195* [0.075]
Overidentification	0.0190 [0.891]	1.638 [0.201]	1.915 [0.166]	1.390 [0.238]	2.316 [0.128]	1.395 [0.238]	0.391 [0.532]

Note: See Table 1 for variable details. Each equation is estimated using two-step efficient GMM with two-way country- and time fixed effects are accounted for in each model. Robust standard errors are in parentheses and probability values are in brackets. For each potentially endogenous logistics variable we used *RAIL* and its own second lag as instruments. Asterisks denote significance levels.

* $p < .1$.

** $p < .05$.

*** $p < .01$.

Plausibly, corruption may impact logistics performance and the ‘friendliness’ of trade policies and processes.⁹ To account for this potential simultaneity, we re-estimate the baseline models using the instrumental variables technique.

4.2 | Accounting for simultaneity between corruption and logistics

To account for potential simultaneity and as a robustness check, we utilise instrumental variables and re-estimate the baseline models employing two-step efficient GMM. To instrument each potentially endogenous logistics measure we use the length of rail lines per capita (*RAIL*) and the two-period lagged value of the endogenous variable. Both variables are likely highly correlated with the endogenous variables and uncorrelated with the error term; however, it should be noted that the chosen instruments reduce the data set almost in half.

The diagnostics tests reported at the bottom of Table 4 shows that the instruments are both relevant and valid given by the significance of the underidentification tests and insignificance of the overidentification tests, respectively (for details of each test see Baum, Schaffer, & Stillman, 2007). The weak identification test results for identifying weak instruments are mixed based on the Stock and Yogo (2005) critical values.

Consistent with the baseline model, the coefficient on *Logistics* is negative and statistically significant, however, the coefficient is considerably larger than that in the baseline model. Rejection of the endogeneity test suggests *Logistics* is indeed endogenous. Nonetheless, improvements in logistics performance lower corruption, even when an account is taken of the two-way causality between corruption and logistics.

Furthermore, the coefficients on all the sub-components are negative and, except for *Timeliness* and *Tracking*, are statistically significant, with *Quality* and *Shipments* having the largest impacts on corruption. This provides further evidence of the importance of better logistics performance in reducing corruption.

Although the logistics measures show support for the baseline models, there is weak statistical evidence in terms of the control variables and their impact on corruption. One exception is political freedom, which is positive and statistically significant in all models except for Model 4.5. Nations with less political freedom are associated with more corruption – this finding reinforces related results in Table 3.

Overall, we find support for Hypothesis 1 and the key insight is that while logistics performance reduces corruption, there are significant quantitative and qualitative differences across its different dimensions. The concluding section follows.

5 | CONCLUSIONS

The importance of smooth supply chains worldwide has been noted by other scholars (see Landesmann & Stöllinger, 2019). However, the functioning of supply chains is dependent in large part on the quality of facilitating institutions.

Recognition of the contribution of regulatory bottlenecks in promoting corruption has been there for quite some time, both in the related theoretical (Rose-Ackerman, 1999; Shleifer & Vishny, 1993) and the empirical literature (Goel & Nelson, 2005). The main argument runs from more economic freedom to lower corruption. This paper tries to add additional insights to this field of inquiry by considering one important aspect of economic performance – logistics

performance. Logistics performance or the efficiency of the supply chain is important both for the demand and supply sides of markets – inputs need to arrive in a timely and coordinated fashion for projects to be completed in an efficient manner. Otherwise, there would be costly delays and cost overruns. Furthermore, deliveries to customers have to arrive on time. Otherwise, there could be penalties or even cancellations. The importance of logistics on both sides of the market thus creates opportunities for rent-seeking and it is useful to understand where the specific bottlenecks are.

Using annual pooled data on about 150 nations, this paper contributes by examining the impact of specific channels of economic freedom on cross-country corruption. Specifically, the different stages of supply chain logistics are examined in terms of their relative impacts on corruption. Besides adding insights into channels of potential corruption or rent-seeking, the research also identifies potential stages of bureaucratic holdups.

Our empirical results show that an improvement in overall logistics performance reduces cross-country corruption. However, not all individual dimensions of supply chain logistics have a similar corruption-reducing impact. Specifically, overall logistics performance improvements and improvements in the performance of tracking and quality dimensions of logistics pay significant dividends in terms of corruption reduction.

Turning to the research questions posed in the Introduction, we provide the following answers:

- What is the impact of improved supply chain logistics performance on cross-country corruption?

Improvements in supply chain logistics tend to lower corruption.

- Are the effects of different dimensions of logistics performance on corruption similar?

No, the effects of the different logistics performance dimensions are not alike on corruption.

In particular, improvements in the performance of tracking and quality dimensions of logistics reduce corruption. On the other hand, changes in the timeliness of shipments dimension of logistics performance do not significantly impact the level of corrupt activity.

From a policy angle, unless logistics performance is comprehensively improved across its various dimensions, piecemeal performance improvements are likely to leave individual stages vulnerable to rent-seeking and overall corruption might remain unchanged. Conversely, in instances where performance improvements in logistics have no appreciable impact on corruption, public resources may be conserved.

Second, the identification of logistics bottlenecks and related corruption provides insights into specific channels of cross-jurisdictional transmission of corruption. Nations that are not necessarily neighbours might face corruption spillovers depending upon whether trade occurs, or an intermediary (corrupt) nation between two trading partners holds a key logistics chain (a strategic infrastructure – the Panama Canal, for example). This insight is in addition to geographic corruption contagion considered in the literature (Becker et al., 2009; Goel & Nelson, 2007) and calls for a comprehensive international corruption-control policy.

Third, the results in Table 3 show that as nations attain greater economic prosperity, the level of corrupt activity goes down (see Serra, 2006). Therefore, policies that promote economic growth would have positive spillovers in terms of corruption reduction.¹⁰

Fourth, the findings with regard to the impact of political freedom (*PolFREE*) or democracy show that corruption generally decreases with greater political freedom. Greater political freedom

enables motivated voters to use the ballot box as a mechanism for removing corrupt bureaucrats and thus also serves as a creditable means to prevent/mitigate corruption. As nations achieve greater democracy, they can expect positive dividends in terms of corruption reduction.

Fifth, our findings also have some implications during the current COVID-19 pandemic times. The pandemic has strained supply chains in several industries, lowering logistics performance (Goel, Saunoris, & Goel, 2020; Singh, Kumar, Panchal, & Tiwari, 2020). Our results suggest that this decreased logistics performance is likely to increase corrupt activity. Therefore, policy makers should redouble their efforts towards fighting corruption as related instances come to light.

Finally, the findings also provide useful inputs for firms' competitiveness policies – firms might consider vertically integrating into logistics stages that are most vulnerable to bureaucratic holdup. In other words, when a logistics stage is incorporated into the firm via vertical integration, any externalities, including ones from possible rent-seeking at that stage, are internalised. For instance, if the firm has its own shipping division, then the firm would not be prone to paying bribes separately at the shipping stage. This insight to the overall corruption literature seems unique.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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ENDNOTES

¹ In another important insight from the organisational theory, DiMaggio and Powell (1983) contend that actors tend to make their organisations increasingly similar and this transition applies to organisations beyond the marketplace – i.e., to state organisations. If that is indeed the case, then we would expect in our analysis that firms might face similar rent-seeking demand across industries and types of logistics.

² <https://lpi.worldbank.org/international>.

³ It is possible that corruption might, in turn, affect logistics performance, and this is accounted for in a subsequent section.

⁴ Given the possible linkages of economic prosperity with many variables, we did a robustness check by taking the lagged or predetermined values of *GDP* and the results remained robust. These results are available upon request.

⁵ Arvis et al. (2018, p. 20) in their detailed discussion of the construction of the LPI note that information and communications technology (ICT) was rated by respondents higher than physical infrastructure.

⁶ A contributing factor to the significance of the *Quality* dimension might be that quality is hard to precisely measure. This ambiguity might be tied to greater rent-seeking potential of corrupt bureaucrats.

- ⁷ The negative effect of *GDP* was also found when its lagged value was used and the other results remained generally unaffected. These results are available upon request.
- ⁸ A contributing factor to the relative insignificance might be that economic prosperity is partly picking up some of the underlying influences (also see footnote 4).
- ⁹ Given the close relation between trade and logistics, we included a country's exports (as a share of *GDP*) as an additional regressor in all the models of Table 3. The resulting coefficient on exports was statistically insignificant, with the other results remaining qualitatively similar. These results are not reported but are available upon request.
- ¹⁰ In a somewhat related aspect, Goel, Saunoris, and Goel (2020) examine the impact of logistics performance on economic growth.

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