Explaining corruption: How do firms respond to non-gravity trade in developing countries?

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Original Research

Keywords: Non-gravity trade, Corruption, Instrument variable, Developing countries

Posted Date: January 29th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-165025/v1

Explaining corruption: How do firms respond to non-gravity trade in developing countries?

Abstract: There has been limited effort to explore whether non-gravity trade, as not driven by standard variables entering an augmented gravity model, matters for firms' corruption. To fill this gap, this paper explores the effect of non-gravity trade on firms' corruption in 141 developing countries during the period 2006-2017. Our results show that non-gravity trade does matter for the firms' corruption behavior. Specifically, we find that firms' corruption decreases by 0.09% to 0.23% following a unit increase in non-gravity trade (e.g. 19.7 million dollars' increase in real trade), and the effect is much larger during the world financial crisis period. The result is robust to exploiting conditional heteroskedasticity for identification, constructing a Bartik-type instrument variable, applying different econometric technics, and using alternative measures of firm corruption.

Keywords: Non-gravity trade; Corruption; Instrument variable; Developing countries
JEL classification: D73; K42; O12; P16

1. Introduction

The adverse effects on firm exports and trade of corruption have been widely recognized by policy makers and the World Bank (Dutt & Traca, 2010; Sequeira & Djankov, 2014; Martins et al., 2020; Qi et al., 2020) . As emphasized by Stigler (1975), until we understand what leads to corruption, we could be poorly equipped to give useful advice on how to combat corruption. A vast of previous literature explores the different determinants of corruptions like economic, political and institutional factors (see Dimant & Tosato, 2018 for a recent survey). One important stream literature lies in investigating the effects of trade on corruption (Dong and Torgler, 2013; Gokcekus and Knorich, 2006; Treisman, 2000). However, there has been limited effort to explore whether non-gravity trade, as not driven by *standard variables entering an augmented gravity model*, matters for firms' corruption. This paper attempts to fill this gap. We investigate the impact of non-gravity trade on firms' corruption behavior in the context of 141 developing countries during the period 2006-2017. This is also a particularly important setting given renewed interest in understanding the micro-level drivers of corruptions (Chatterjee & Ray, 2012; You & Nie, 2017).

Non-gravity trade, as suggested by Brueckner, Long & Vespignani (2020), is the exchange of goods and services that is not determined by standard variables entering a gravity equation. In the spirit of this definition, we construct our measure of non-gravity trade[1] between two countries as the residual in a gravity equation, following Head et al. (2010). For the total non-gravity trade for one (i.e. home) country, the measure comes from taking a weighted average of its residuals. The weights, in turn, are based on other (i.e. foreign) countries' trade share with the home country. Thus, the total non-gravity trade of a country is calculated as a weighted average indicator. To measure the extent that enterprises are affected by non-gravity trade, we use the enterprise's trade shares as weights to derive our main interested variable, firm-level non-gravity trade, which helps to fit the firm-level corruption indicator used in the current study. We find

that non-gravity trade negatively affects firm's corruption in developing countries.

In order to identify the effect of non-gravity trade on firms' corruption, one may concern about the endogeneity issue of non-gravity trade. First, non-gravity trade is plausibly seen as an exogenous shock to micro-firms, accounting for the variation of trade driven by non- fundamental components. It is mainly because the national level non-gravity trade is predicted using a gravity model, and normally individual firms only contribute little to its variations. In addition, as complementary casual identification strategies, an aggregate instrument variable (e.g. average non-gravity trade for each industry at the ISIC 2-digit level) is constructed in this paper to uncover the casual effect of non-gravity trade on firms' corruption following the logic of previous casual identification studies (Bentolila et al., 2010; Card & Krueger, 1996; Evans et al., 1992). Furthermore, we apply estimation approach that identifies the effect by exploiting conditional heteroskedasticity, following Lewbel (2012, 2019) (see also, Baum et al., 2012; Baum & Lewbel, 2019; Klein & Vella, 2010). Our instrumental approach shows that firms' corruption decreases by 0.23% at most following a unit increase in non-gravity trade (e.g. 19.7 million dollars' increase in real trade), and the effect is much larger during the world financial crisis period.

This work builds on the growing literature that examines the effects of trade on corruption. It has been found that corruption is negatively associated with trade (Dong & Torgler, 2012; Dutt, 2009; Gokcekus & Knörich, 2006; Neeman et al., 2008; Treisman, 2000), and the potential mechanism is that greater openness could alter both the political–economic structure of the country and social norms. However, whether and how the non-gravity trade affects corruption remains unsolved. As the first work studying this relation, to the best of our knowledge, this work contributes a new perspective to explore the causes of corruption. In addition to augmenting the literature by looking into a non-fundamental determinant of corruption, the paper links the stream of literature to the one that studying how income affects corruption. This rationale is that non-gravity trade affects income variation (Acemoglu et al., 2001), and 'if other factors lead to vigorous economic development, corruption is likely to decrease

(Treisman, 2000). It has been found that richer countries tend to have less corruption which is usually used as the proxy for governance (Cole, 2007; Glaeser et al., 2004; Husted, 1999; Paldam & Gundlach, 2008), and the underlying reason is that wealthier countries tend to have better institutions (See Treisman, 2000; Graeff & Mehlkop, 2003; Lambsdorff, 2006; Serra, 2006). However, those previous analyses focus on the effects of income, driven by fundamental factors, has on corruption. This study instead employs non-gravity trade as a non-fundamental determined indicator and examines the effect that non-gravity trade driven income variations have on firms' corruption.

This non-gravity trade variation is measured by the unforecastable component of the linear model (Jurado et al. 2015), which could be seen as one uncertainty shock to firms. Non-gravity trade displays much volatility than that of gravity trade and this stylized fact is confirmed through applying a variety of specifications of the gravity equation (Brueckner, Long & Vespignani, 2020) Thus, this work is also related to the stream of literature investigating the relationship between uncertainty and corruption which receives little attention. As documented by previous research, economic uncertainty is positively related to corruption based on empirical analysis from a large cross-country sample (Goel & Ram, 2013). In addition, political uncertainty increases corruption in different variations and time periods and the result is robust when alternate dimensions are considered (Goel & Saunoris, 2017). This work is different with them in two aspects. First, we aim at identifying whether non-fundamental factors measured by non-gravity trade matter for firms' corruption while they look at how uncertainty determined by fundamental factors affects corruption at country level. Second, the impact of non-gravity trade on corruption is found to be negative while that of economic and political uncertainty is positive, and this is because the increase of non-gravity trade stimulates economy while the other two bring more risks.

The remainder of this paper is structured as follows. Non-gravity trade is discussed in section 2. The data and methodology are presented in Section 3. Section 4 examines the effect of non-gravity trade on perceived corruption at the firm level, using different indicators and methods of estimation. Section 5 concludes.

2. Non-gravity trade

The interested variable in this paper is non-gravity which accounts for the variation of trade driven by non- fundamental components. We construct this indicator at the firm-level in three steps. First, non-gravity trade between home and foreign countries is estimated as the residual of a traditional gravity model (Brueckner, Long & Vespignani, 2020; Tian et al., 2020). Second, based on the derived residuals, we compute the country level non-gravity trade as a weighted average taking trade shares as weights. Third, the firm level non-gravity trade is computed as the product of the country level non-gravity trade and the total share of trade for each firm, where the total share is the sum of the proportion of total sales that are exported directly and indirectly, and the proportion of total inputs that are of foreign origin.

Step 1: Non-gravity trade is formally defined as an unforecastable component of a linear estimation. In this paper, we apply this methodology in a gravity equation following Head et al. (2010). Non-gravity trade is constructed as the residual of a gravity equation (Brueckner, Long & Vespignani, 2020; Tian et al., 2020)). The estimated gravity equation is as following:

$$log(\frac{Bilateral\ Trade_{ijt}}{GDP_{it}}) = \beta_0 + \beta_1\, log(population_{it}) + \beta_2 log\left(Distance_{ij}\right) + \beta_3\, log(Area_i) +$$

$$\beta_4 Border_{ij} + \beta_5 Locked_i + \beta_6 Language_{ij} + \beta_7 Colonial_{ij} + \beta_8 Tradement_{ijt} + v_{ijt}, \quad (2)$$

where $\log\,(\text{Bilateral trade/GDP})_{ijt}$ is the ratio of exports plus imports between country i and country j, divided by nominal GDP of country i. Population is the country's population. $Distance_{ij}$ is the geographic distance between country i and country j. $Area_i$ is the country's area (measured in square kilometers). $Border_{ij}$ is a dummy variable for countries that share a border. $Locked_i$ is a dummy variable for landlocked countries. $Language_{ij}$ is dummy variable indicating that two counties use the same language. $Colonial_{ij}$ is dummy variable for the same colonies. $Tradement_{ijt}$ is a dummy variable indicating that two countries have free trade agreement in year t. The detailed description of the all variables can be found in

Appendix Table 1, and a list of 190 countries used in the gravity model can be found in Appendix Table 2.

The coefficients β_1 to β_8 are parameters to be estimated, and v_{ijt} is an error term. Following the definition of non-gravity trade, the residual ($\widehat{v_{ijt}}$) on the estimates of equation (2) is our interested variable. Thus, non-gravity trade is the variation of the log of bilateral trade/nominal GDP that cannot be explained by variables that the trade literature has found to be significant determinants of trade (Brueckner, Long & Vespignani, 2020; Tian et al., 2020).

Step 2: The second step is to calculate the non-gravity trade of country i in year t. It is calculated as a weighted average indictor ($NG - Trade_{it}$). The weights, in turn, are based on other (i.e. foreign) countries' trade share with the home country. Thus, it is calculated as

$$NG\_Trade_{it} = \sum_{j=1}^{n} \widehat{v_{ijt}} \frac{Trade_{ijt}}{Total\ trade_{it}}, \tag{3}$$

where $\frac{Trade_{ijt}}{Total\ trade_{it}}$ is the share of trade between country i and country j. $\widehat{v_{ijt}}$ is the residual predicted based on equation (2) with Ordinary Least Square (OLS) estimation.

Step 3: The third step is to compute the firm-level non-gravity trade, which is main interested variable in this work. To be consistent with the target of this paper and the measurement of the dependent variable, we use equation (4) to calculate this indicator.

$$NG\_Trade_{fit} = NG\_Trade_{it} * total\ share\ of\ trade_{fit}, \tag{4}$$

where NG_Trade_{fit} indicates non-gravity trade for firm f in country i at time t, NG_Trade_{it} is the non-gravity trade of country i in year t as calculated in step 2, and $total\ share\ of\ trade_{fit}$ measures the openness degree of firm f in country i at time t. This constructed indicator could effectively capture the effects of non-gravity trade on firms depending on their openness degree.

3. Data sources, variables, and empirical methodology

3.1 Data sources

The main data source is the firm-level database provided by the World Bank

Enterprise Surveys (WBES), spanning a wide range of developing countries during the period 2006-2017. In total, the stratified random sample data cover 136,887 firms in 141 countries. The firms were surveyed through face-to face interviews with manager and owners. The dataset contains detailed firm-level information on domestic sales, exports, imports, firm size and age, ownership, and legal status. The macro-level institutional quality indicators like access to finance, political stability, tax administrations and tax rates are also included. In particular, the dataset contains information on firm-level perception of corruption, which is used as the dependent variable here. The main interested variable, non-gravity trade, is estimated through applying the gravity model with the data from Rose (2019).

3.2 Variables

Corruption

The main firm-level corruption measure draws from firm's response to the question "in reference to that application for an import license, was an informal gift or payment expected or requested". We adopt this indicator that focus on bribes to secure import licenses as the dependent variable because it fits our study the best. To deal with the potential endogenous issue, we further calculate a Bartik-type variable to identify the causal effect following the idea of Liu et al. (2020).

$$Cor_{ijt} = AC_{it} \times IC_j, \tag{5}$$

where AC_{it} is the average reported corruption for firms in country i in year t, and IC_j is the average corruption for firms in industry j (denoted at the ISIC 2-digit level) worldwide. Using such a measure partially removes the idiosyncratic components of the firm-level reported corruption, and potentially alleviates the endogeneity problem. For robustness checks, we further apply other alternative corruption measurement indicators to confirm our results.

Control variables

We control for two categories of factors that may potentially correlated with our interested variable, non-gravity trade. The first type of variables includes firm-level characteristics such as firm ownership (foreign vs. domestic), firm age and size,

manager experience in the industry, employment, legal status, proportion of government ownership, and proportion of other ownership. The second is related to institutional quality, such as financial constraint, political instability, tax administrations and tax rates. Controlling those variables could help to reduce the omitted variable biases. Definitions of all the variables and summary statistics are shown in the following Table 1.

Table 1 Definitions of all the variables and summary statistics

Variables	Definitions	Obs.	Mean	Std. Dev.	Min	Max
Dependent variable						
Corruption	Percent of firms expected to give gifts to get an import license	130,133	1.76	13.15	0	100
Interested variable						
NG_Trade	Trade shock is not determined by standard variables entering a gravity equation	130,133	-22.70	2.44	-25.56	0
Control variables-Firm characteristics						
Export status	If the firm exports, the value equals to 1, 0 otherwise	135,292	13.74	34.43	0	100
Ownership	Foreign vs. domestic	134,541	10.68	30.89	0	100
Size	Small, medium, and large	136,887	1.72	0.77	1	3
Manager's experience	Years of the top manager's experience working in the firm's sector	132,868	17.31	11.03	0	60
Employment	Number of workers	134,817	79.60	205.70	0	6128
Legal status	Legal status of the firm	135,820	2.79	1.07	1	7
Age	Age (years)	134,160	18.15	15.40	0	214
State ownership	Proportion of government/state ownership in a firm (%)	134,535	0.66	6.39	0	100
Control variables-Institutional quality						
Finance constraint	Access to finance	129,708	15.02	35.73	0	100
Political instability	Political instability	129,708	10.51	30.67	0	100
Tax administration	Tax administration	129,708	3.26	17.75	0	100
Tax rates	Tax rates	129,708	11.74	32.19	0	100

3.3 Identification strategy

3.3.1 Identification specification

To examine the effects of non-gravity trade on corruption, we conduct the following regression:

$$Corruption_{fit} = \alpha + \beta * NG\_Trade + \gamma X_{fit} + \mu_i + \mu_t + \mu_{ind} + \varepsilon_{fit} \quad (6),$$

where $Corruption_{fit}$ is the corruption reported by firm f of country i in year t. NG_Trade indicates non-gravity trade at the firm level as calculated in section 2. Non-gravity trade is plausibly seen as an exogenous shock to micro-firms, accounting for the variation of trade driven by non-fundamental components. It is mainly because that the national level non-gravity trade is predicted using a gravity model, and normally individual firms only contribute little to its variations. X_{fit} is a vector of controls including firm ownership, firm age and size, manager experience in the industry, employment, legal status, proportion of government ownership, proportion of other ownership, and a set of institutional quality controls, such as financial constraint, political instability, tax administrations and tax rates. We let μ_i and μ_{ind} be generic representation of country fixed effects and industry fixed effects that capture all time invariant country-specific and industry-specific characteristics and permanent differences. μ_t denotes the year fixed effects, which is modelled to remove the time-varying macroeconomic worldwide common shocks that affect the developing countries identically. ε_{fit} is the idiosyncratic error term clustered at the country-year level.

3.3.2 Instrument variable approach

Even we have discussed that non-gravity trade could be potentially seen as an exogenous shock to micro-firms, and we add the control variables mentioned above to satisfy the conditional independence assumption (CIA) to uncover the casual effect (Angrist & Pischke, 2008), one may still concern about the endogeneity issue of non-gravity trade. To deal with the potential endogeneity issue, we develop an aggregate instrument variable at industry-year level following the ideas of Evans et al. (1992), Card & Krueger (1996) and Bentolila et al. (2010). Specifically, in this paper, we

construct an average non-gravity trade for each industry at the ISIC 2-digit level at year t. This instrument variable for micro-level firms is denoted as $NG - Trade - IV$.

3.3.3 A complementary approach

As a complementary approach, we apply another estimation approach proposed by Lewbel (2012). This estimator exploits heteroskedasticity for identification and eliminates the concern about exclusionary restriction associated with using instrument variables. It is constructed in the following way as equation (7) shows,

$$Lewbel - IV = (z - \bar{z})(\widehat{u_{it}}), \tag{7}$$

where $\widehat{u_{it}}$ is the residual derived by regressing the potential endogenous variable on all the control variables, and $\bar{z}$ is the mean of non-gravity trade. As shown by (Lewbel, 2012, 2018, 2019), excellent candidates for the z vector are the variables that may alternatively be used as instruments in a given context. Accordingly, in the context of our application, we use the mentioned instrument of non-gravity trade as z and implement the two-stage estimator proposed by Lewbel (2012; 2019).

First, the residuals $\widehat{u_{it}}$ are retrieved by regressing non-gravity trade on all the control variables. Following Lewbel (2012), we use the Breusch–Pagan test of heteroskedasticity which satisfies the requirement to construct the instrument variable. The new instrument variable is therefore can be created by equation (7). Second, we use $(z - \bar{z})\,\widehat{u_{it}}$ as the instrument variable to identify the causal effects of non-gravity trade on the changes in firms' corruption.

4. Results

4.1 Benchmark results

Table 2 reports the OLS estimation of the causal effect of non-gravity trade on firm corruption, with robust standard errors clustered at the country level (in parentheses). Column (1) presents the baseline results without considering all the other control variables. Column (2) and (3) successively control for more firm-characterized variables, and the coefficient of interest goes down beyond doubt. The variable "Customs and trade regulations" is added in Column (4), and the results show that the

negative relation is reinforced when this institution factor is taken into account. More such factors are put in the last column, but it turns out that they are not playing a role and the coefficient of interest barely changes. Overall, we find that firm reported corruption is significantly negatively correlated with non-gravity trade. A unit of non-gravity trade increase contributes to at least 0.08% decrease in corruption.

Table 2 Effects of non-gravity trade on corruption: Baseline results

Variable	**Corruption**				
	(1)	(2)	(3)	(4)	(5)
NG_Trade	-0.112***	-0.079***	-0.072***	-0.087***	-0.088***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
Export status		0.012***	0.009***	0.008***	0.008***
		(0.002)	(0.002)	(0.002)	(0.002)
Age		-0.025***	-0.026***	-0.019***	-0.019***
		(0.002)	(0.002)	(0.003)	(0.003)
Size		0.818***	0.354***	0.380***	0.379***
		(0.055)	(0.068)	(0.069)	(0.069)
Ownership type			0.014***	0.009***	0.009***
			(0.002)	(0.002)	(0.002)
Employment			0.003***	0.002***	0.002***
			(0.000)	(0.000)	(0.000)
Legal status			0.155***	0.090**	0.090**
			(0.037)	(0.037)	(0.037)
Government ownership				-0.001	-0.001
				(0.007)	(0.007)
Manager's experience				-0.016***	-0.016***
				(0.004)	(0.004)
Customs and trade regulations				0.016***	0.016***
				(0.003)	(0.003)
Financial constraint					-0.000
					(0.001)
Political instability					-0.001
					(0.001)
Tax administration					0.001
					(0.002)
Constant	1.219***	0.266***	0.312**	0.574***	0.583***
	(0.037)	(0.088)	(0.145)	(0.156)	(0.157)
Observations	130133	126210	122542	114234	114234
R-squared	0.006	0.010	0.013	0.012	0.012

Notes: *i)* Clustered standard errors in parentheses; *ii)* *** p<0.01, ** p<0.05, * p<0.1.

Even we have added the control variables to satisfy the conditional independence

assumption (CIA) (Angrist and Pischke, 2008) in Table 2, there may be some other variables omitted, like those variables that are not observable or unmeasurable. Fixed effects models are applied to deal with this type of omitted variable problem, and the results are reported in Table 3. We first add the year fixed effects, removing the worldwide common shocks in corruption. The results show that non-gravity trade still has a significant negative association with corruption, and the effect size changes little. Next, we further add country and industry fixed effects in column (2) and (5). Particularly, as the last column shows, the way and the extent of how non-gravity trade affects corruption remain the same when all the year, country and industry fixed effects are controlled, compared to the baseline results. With the other two combinations of fixed effects being controlled, column (3) and (4) generate the similar results. These estimations further support the finding that the firm-level perceived corruption is decreasing in non-gravity trade. The effect size is around 0.08 which is robust with the results reported in Table 2. The potential measurement error issue may lead to the downward estimation bias in the OLS regression as shown in Table 2 and Table 3.

Table 3 Effects of non-gravity trade on corruption: Fixed-effect models

Variable	**Corruption**				
	(1)	(2)	(3)	(4)	(5)
NG_Trade	-0.085***	-0.066***	-0.109***	-0.088***	-0.087***
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)
Export status	0.008***	0.011***	0.007***	0.011***	0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Age	-0.017***	-0.012***	-0.014***	-0.012***	-0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Size	0.404***	0.479***	0.460***	0.538***	0.513***
	(0.070)	(0.069)	(0.070)	(0.070)	(0.069)
Ownership type	0.009***	0.010***	0.008***	0.009***	0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Employment	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Legal status	0.085**	-0.059	0.097**	-0.091**	-0.057
	(0.039)	(0.043)	(0.039)	(0.043)	(0.043)
Government ownership	-0.001	-0.003	-0.002	-0.001	-0.003
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Manager's experience	-0.008**	0.005	-0.007*	0.004	0.006*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)

Customs and trade regulations	0.016***	0.014***	0.015***	0.013***	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Financial constraint	-0.001	-0.002**	-0.000	-0.002*	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Political instability	0.001	-0.004***	0.001	-0.006***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tax administration	0.002	0.003	0.001	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Year fixed effect	YES	YES	YES	NO	YES
Country fixed effect	NO	YES	NO	YES	YES
Industry fixed effect	NO	NO	YES	YES	YES
Constant	0.082	4.189***	-0.584***	3.973***	3.555***
	(0.188)	(0.865)	(0.193)	(0.789)	(0.866)
Observations	114234	114234	114234	114234	114234
R-squared	0.016	0.047	0.017	0.045	0.048

Notes: *i)* Clustered standard errors in parentheses; *ii)* *** p<0.01, ** p<0.05, * p<0.1.

4.2 IV regression results

As noted in the last section, the average non-gravity trade at the industry level is taken as the instrument variable to deal with endogeneity, and a two-stage least square (2SLS) estimator is further employed to tackle the issue of exclusionary restriction associated with using an IV. The corresponding results in details are presented in this subsection.

Table 4 reports the results taking the average non-gravity trade as the instrument via different methods of estimation. Column (1) to (3) are 2SLS estimates of fixed effects models, and the first stage F-statistic indicates that this aggregate instrument variable is effective. The significant negative relationship between non-gravity trade and corruption still exits and the effect size is amplified as it is underestimated under OLS regression because of the measurement errors. Specifically, as shown in column (3) where all the year, country and industry fixed effects are controlled, 1 unit increase in non-gravity trade decreases the level of corruption by around 0.15 percentage point. We further identify the causal effect of non-gravity trade on firm perceived corruption using generalized method of moments (GMM), and the results shown in column (4) provide robust evidence of our finding. The effect size under the IV estimation is almost twice as that reported in Table 3. Potentially, the instrument variable not only deals with

the endogenous issue, but also solves the measurement error problem of non-gravity trade.

Table 4 Instrument variable estimation results

	(1) 2SLS	(2) 2SLS	(3) 2SLS	(4) GMM
NG_Trade	-0.119***	-0.093***	-0.150***	-0.150***
	(0.026)	(0.032)	(0.022)	(0.009)
Other controls	YES	YES	YES	YES
Leave-out average	0.890***	0.888***	0.873***	
	(0.445)	(0.047)	(0.047)	
First-stage F-statistic	397.71	363.49	339.19	
Other controls	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Country fixed effect	NO	YES	YES	YES
Industry fixed effect	NO	NO	YES	YES
Observations	114234	114234	114234	114234

Notes: *i)* Clustered standard errors in parentheses; *ii)* *** p<0.01, ** p<0.05, * p<0.1; *iii)* firm ownership, firm age, manager experience in the industry, firm size, employment, legal status, proportion of government ownership, and proportion of other ownership, financial constraint, political instability, tax administrations are all controlled at the first and second stages.

4.3 Identification through heteroskedasticity as a complementary approach

The following Table 5 presents the estimation results using the Lewbel instrument variable obtained by equation (7) via the same estimation methods as shown in Table 4. The heteroskedasticity is very strong in terms of errors in the first-stage regressions, which could sufficiently satisfy the heteroskedasticity requirement for applying Lewbel estimation approach. The point estimates are statistically significant at a 1% level, and the effect size is strengthened under this method. In particular, the estimates of 2SLS and GMM model taking all the fixed effects into account (in the last two columns) are the same, and they show that an increase of 1 percentage point in non-gravity trade reduces the level of corruption by almost 0.21 percentage points.

Therefore, both the benchmark and IV regression results provide robust evidence that non-gravity trade has a significant negative impact on the perceived corruption at the firm level. This is contrary to how economic and political uncertainty impact corruption. The underlying reason could be that an increase in non-gravity trade driven by non-fundamental factors results in economic development which in turn reduces corruption, while the other two types of uncertainty put economic agents at more risks such that corruption, as a way of risk prevention, becomes more attractive.

Table 5 Non-gravity trade and corruption: Identification through heteroskedasticity

	(1)	(2)	(4)	(5)
	2SLS	2SLS	2SLS	GMM
NG_Trade	-0.226***	-0.207***	-0.208***	-0.208***
	(0.023)	(0.023)	(0.017)	(0.013)
Other controls	YES	YES	YES	YES
$(z-\bar{z})\,\widehat{u_{it}}$	-0.091	-0.091***	-0.090***	
	(0.008)	(0.007)	(0.003)	
First-stage F-statistic	116.62	169.78	682.26	
Other controls	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Country fixed effect	NO	YES	YES	YES
Industry fixed effect	NO	NO	YES	YES
Observations	114234	114234	114234	114234

Notes: *i)* Clustered standard errors in parentheses; ii) *** p<0.01, ** p<0.05, * p<0.1; iii) firm ownership, firm age, manager experience in the industry, firm size, employment, legal status, proportion of government ownership, and proportion of other ownership, financial constraint, political instability, tax administrations are all controlled at the first and second stages.

4.4 Robustness checks

4.4.1 Different measurement of corruption

The effect of non-gravity trade may be sensitive to different corruption indexes. For this reason, we make robustness checks and present the outcomes in Table 6. Taking the other corruption indicators in the survey as the dependent variable, the

estimates shown in Table 6 provide evidence that the relationship between firms' perceived corruption and non-gravity trade is not sensitive to the use of different indexes of corruption. In particular, the positive point estimate (0.208) for the last measurement also supports the argument that the increase in non-gravity trade can lead to a lower level of corruption because this proxy is contrary to the other corruption indicators as it measures the ratio of firms which believe that the court system is fair, impartial and uncorrupt. There exists one exception that the estimate is insignificant when corruption is measured by the percent of firms expected to give gifts to get a phone connection. With the popularization of telephone, obtaining telephone connection is no longer a constraint for enterprises to set up and operate. The results show that non-gravity trade affects firms' corruption through the bribery behaviors of both customs-related and non-exporting related officials in emerging countries, which is different from Gatti (2004) who finds that openness does not lead the corruption behaviors related to non-customs officials.

Table 6 Non-gravity trade on corruption (Robustness checks I)

Percent of firms expected to give gifts in meetings with tax officials	-0.067***(0.018)
Percent of firms expected to give gifts to secure a government contract	-0.100***(0.014)
Value of gift expected to secure government contract	-0.008***(0.001)
Percent of firms expected to give gifts to public officials	-0.255***(0.024)
Percent of firms expected to give gifts to get a phone connection	-0.007 (0.006)
Percent of firms expected to give gifts to get an electrical connection	-0.033***(0.009)
Percent of firms expected to give gifts to get a water connection	-0.024***(0.006)
Percent of firms expected to give gifts to get a construction permit	-0.049***(0.010)
Percent of firms expected to give gifts to get an operating license	-0.066***(0.013)
Percent of firms identifying corruption as a major constraint	-0.212***(0.027)
Percent of firms believing the court system is fair, impartial, and uncorrupted	0.208*** (0.029)

Notes: *i)* Clustered standard errors in parentheses; *ii)* *** p<0.01, ** p<0.05, * p<0.1; *iii)* firm ownership, firm age, manager experience in the industry, firm size, employment, legal status, proportion of government ownership, and proportion of other ownership, financial constraint, political instability, tax administrations are all controlled at the first and second stages.

4.4.2 A Bartik-type corruption

Next, we use the Bartik-type variable generated by equation (5) to identify the causal effect of non-gravity trade on corruption, and the results are performed in Table 7. Not only is this a robustness check with a different type of corruption index, but also a way of mitigating the endogeneity problem. Following the framework of identification discussed above, we estimate the causal effect with the methods of two-stage least square (2SLS) by employing the two instrument variables introduced above respectively. The outcomes show that non-gravity trade still has a significant negative impact on corruption even the effect size drops, providing robust evidence that the main result can survive with various measure of corruption.

Table 7: Non-gravity trade on corruption (Robustness checks II)

	(1) 2SLS		(2) 2SLS
NG_Trade	-0.017***	NG_Trade	-0.017***
	(0.008)		(0.002)
Other controls	YES	Other controls	YES
Leave-out average	0.873	$(z-\bar{z})\,\widehat{u_{it}}$	-0.091***
	(0.047)		(0.003)
First-stage F-statistic	339.19	First-stage F-statistic	682.26
Other controls	YES	Other controls	YES
Year fixed effect	YES	Year fixed effect	YES
Country fixed effect	YES	Country fixed effect	YES
Industry fixed effect	YES	Industry fixed effect	YES
Observations	114234	Observations	114234

Notes: *i)* Clustered standard errors in parentheses; *ii)* *** p<0.01, ** p<0.05, * p<0.1; *iii)* firm ownership, firm age, manager experience in the industry, firm size, employment, legal status, proportion of government ownership, and proportion of other ownership, financial constraint, political instability, tax administrations are all controlled at the first and second stages.

4.4.3 Different time periods and adding more control variable

The effect may also be heterogeneous in different time periods, and with more variables under control. The following estimations try to tackle this issue by using the

complementary approach using the Lewbel-IV. Specifically, Column (1) - (3) in Table 8 checks the robustness of negative relation between non-gravity trade and corruption over 3 durations (namely the time of period from 2006-2009, 2010-2012 and 2013-2017), verifying that the relationship does exist. The effect is much larger during the financial period 2006-2009, and a drastic fall in the effect size can be seen from this period to the last two. It may be attributed to that the firms' corruption behavior is much more sensitive to the incomes driven by non-gravity trade during hard times. Column (4) and (5) further examine the relationship by successively adding tax rate and transport as the extra control variables of institutional characteristics. It turns out that the point estimation remains the same as that in Table 5. Overall, these estimations provide robust evidence that the increased non-gravity trade can lead to a lower level of reported corruption at the firm level.

Table 8 Non-gravity trade and corruption: Identification through heteroskedasticity

Second stage dependent variable: Corruption					
	(1)	(2)	(3)	(4)	(5)
	2006-09	2010-12	2013-17	2SLS	GMM
NG_Trade	-0.317***	-0.101***	-0.092***	-0.208***	-0.208***
	(0.039)	(0.003)	(0.004)	(0.017)	(0.017)
Other controls	YES	YES	YES	YES	YES
First stage dependent variable: NG-Trade					
$(z-\bar{z})\,\widehat{u_{it}}$	-0.088	-0.078***	-0.087***	-0.091***	-0.091
	(0.008)	(0.004)	(0.008)	(0.003)	(0.003)
First-stage F-statistic	886.27	927.79	521.43	681.79	682.03
Other controls	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES
Observations	40696	22425	51113	114234	114234

Notes: *i)* Clustered standard errors in parentheses; *ii)* *** p<0.01, ** p<0.05, * p<0.1; *iii)* firm ownership, firm age, manager experience in the industry, firm size, employment, legal status,

proportion of government ownership, and proportion of other ownership, financial constraint, political instability, tax administrations are all controlled at the first and second stages from column (1) to column (3); *iv)* tax rate and transport as the extra control variables are successively added in column (4) and (5).

5. Concluding remarks

Corruption can be explained by various socio-economic, political and institutional factors. Among these factors, fundamental ones, such as economic growth, political structure and legal system, receive much more attention than the non-fundamental ones like non-gravity trade. Although it has been argued that trade is an important determinant to corruption (Dong & Torgler, 2012; Gokcekus & Knörich, 2006; Neeman et al., 2008; Treisman, 2000), how non-gravity trade, as not driven by standard variables entering a gravity equation affects corruption remains unknown.

In this paper, we quantify the effects of firm-level non-gravity trade on perceived corruption by using a large sample country over the period 2006–2017. The results show that non-gravity trade is negatively linked to corruption and it is robust against various identification strategies and measures of corruption. The potential mechanism is that non-gravity trade of a country affects firm's income (Brueckner, Long & Vespignani, 2020; Tian et al., 2020), and the increased income level in turn deters corruption. The present study therefore mainly contributes to the literature by providing a new perspective on the determinants of corruption and identifying that the non-fundamental driven trade can deter corruption at firm level in the developing countries.

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Appendix

Table A1: Variable descriptions used in the gravity model

Variables	Description
$log(\frac{Bilateral\ Trade_{ijt}}{GDP_{it}})$	Logarithm of exports plus imports between country i and country j, divided by nominal GDP of country i
$population_{it}$	Population is the country's i population. All residents regardless of legal status or citizenship.
$Distance_{ij}$	The distance of country i and country j, measured in kilometers.
$Border_{ij}$	The border is a dummy variable for countries. It takes the value of 1 if they share a border, and 0 otherwise.
$Locked_i$	Dummy variable which takes the value of 1 if the country has access to open sea, and 0 if it is landlocked.
$Language_{ij}$	Dummy variable which takes the value of 1 if the two countries have a common language and 0 otherwise.
$Colonial_{ij}$	Dummy variable which takes the value of 1 if two countries belong to the same colony, and 0 other wise
$Freetrade_{ijt}$	Dummy variable which takes the value of 1 if the two countries has a free trade agreement and 0 otherwise.

Table A2: List of countries used in the gravity model estimation

Afghanistan	Dominica	Lao People's Dem Rep	Serbia
Albania	Dominican Republic	Latvia	Serbia & Montenegro
Algeria	Ecuador	Lebanon	Seychelles
American Samoa	Egypt	Lesotho	Sierra Leone
Angola	El Salvador	Liberia	Singapore
Antigua and Barbuda	Equatorial Guinea	Libya	Slovak Republic
Argentina	Eritrea	Lithuania	Slovenia
Armenia	Estonia	Macao, China	Solomon Islands
Aruba	Ethiopia	Macedonia	Somalia
Australia	Faeroe Islands	Madagascar	South Africa
Austria	Fiji	Malawi	Spain
Azerbaijan	Finland	Malaysia	Sri Lanka
Bahamas	France	Maldives	St. Kitts & Nevis
Bahrain	French Polynesia	Mali	St. Lucia
Bangladesh	Gabon	Malta	St.Vincent & Grenadines
Barbados	Gambia, The	Martinique	Sudan
Belarus	Georgia	Mauritania	Suriname
Belgium-Luxembourg	Germany	Mauritius	Swaziland
Belize	Ghana	Mexico	Sweden
Benin	Greece	Moldova	Switzerland
Bermuda	Greenland	Mongolia	Syrian Arab Republic
Bhutan	Grenada	Morocco	Tajikistan
Bolivia	Guadeloupe	Mozambique	Tanzania
Bosnia & Herzegovina	Guam	Myanmar	Thailand
Botswana	Guatemala	Namibia	Timor-Leste
Brazil	Guiana, French	Nepal	Togo
Brunei	Guinea-Bissau	Netherlands	Tonga
Brunei Darussalam	Guyana	Netherlands Antilles	Trinidad &Tobago
Bulgaria	Haiti	New Caledonia	Tunisia
Burkina Faso	Honduras	New Zealand	Turkey
Burundi	Hong Kong, China	Nicaragua	Turkmenistan
Cabo Verde	Hungary	Niger	Tuvalu
Cambodia	Iceland	Norway	Uganda
Cameroon	India	Oman	Ukraine
Canada	Indonesia	Pakistan	United Arab Emirates
Central African Republic	Iran, Islamic Rep.	Palau	United Kingdom
Chad	Iran, Islamic Rep	Panama	United States
Chile	Ireland	Papua New Guinea	Uruguay
China	Israel	Paraguay	Uzbekistan
Colombia	Italy	Peru	Vanuatu
Comoros	Jamaica	Philippines	Venezuela, RB
Congo, Dem	Japan	Poland	Vietnam
Congo, Rep.	Jordan	Portugal	West Bank and Gaza
Costa Rica	Kazakhstan	Qatar	Yemen
Cote d`Ivoire	Kenya	Romania	Yemen, Rep.
Croatia	Kiribati	Russia	Zambia
Cuba	Korea, Republic of	Russian Federation	Zimbabwe
Cyprus	Kosovo	Rwanda	
Czech Republic	Kuwait	Samoa	
Denmark	Kyrgyzstan	Sao Tome and Principe	
Djibouti	Lao PDR	Senegal	

Table A3: List of countries for World Bank Enterprise Surveys

Afghanistan	Gabon	Pakistan
Albania	Gambia	Panama
Angola	Georgia	Papua New Guinea
Antigua and Barbuda	Ghana	Paraguay
Argentina	Grenada	Peru
Armenia	Guatemala	Philippines
Azerbaijan	Guinea	Poland
Bahamas	Guinea-Bissau	Romania
Bangladesh	Guyana	Russian Federation
Barbados	Honduras	Rwanda
Belarus	Hungary	Samoa
Belize	India	Senegal
Benin	Indonesia	Serbia and Montenegro
Bhutan	Iraq	Sierra Leone
Bih	Israel	Slovak Republic
Bolivia	Jamaica	Slovenia
Botswana	Jordan	Solomon Islands
Brazil	Kazakhstan	South Africa
Bulgaria	Kenya	South Sudan
Burkina Faso	Kosovo	Sri Lanka
Burundi	Kyrgyzstan	St. Kitts and Nevis
Cabo Verde	Lao People's Dem.Rep	St. Lucia
Cambodia	Latvia	St. Vincent & Grens.
Cameroon	Lebanon	Sudan
Central African Rep.	Lesotho	Suriname
Chad	Liberia	Sweden
Chile	Lithuania	Tajikistan
China	Madagascar	Tanzania
Colombia	Malawi	Thailand
Congo, Dem. Rep. of	Malaysia	Timor-Leste
Costa Rica	Mali	Togo
Cote d'Ivoire	Mauritania	Tonga
Croatia	Mauritius	Trinidad and Tobago
Czech	Mexico	Tunisia
Djibouti	Micronesia	Turkey
Dominica	Moldova	Uganda
Dominican Republic	Mongolia	Ukraine
Drc	Montenegro	Uruguay
Ecuador	Morocco	Uzbekistan
Egypt	Mozambique	Vanuatu
El Salvador	Myanmar	Venezuela, Rep. Bol.
Eritrea	Namibia	Vietnam
Estonia	Nepal	West Bank and Gaza
Eswatini	Nicaragua	Yemen, Republic of
Ethiopia	Niger	Zambia
Fiji	Nigeria	Zimbabwe
Fyrom		