Trade openness, corruption, and factor abundance: evidence from a dynamic panel

Abstract
Using the Heckscher-Ohlin-Samuelson-Vanek (HOSV) framework, this paper illustrates a relationship between corruption and the pattern of international trade that depends on the factor endowments of countries. We empirically investigate this relationship between trade openness and corruption by using a panel dataset on trade openness, corruption, and capital-labor ratio, and applying estimation techniques developed for dynamic panels. Our regression results provide strong support to the hypothesis that the effect of corruption on trade openness depends on factor abundance.

JEL Classification code: D5; D73; F1; O17.
Keywords: Corruption; comparative advantage; trade openness; factor endowments.

1. Introduction
This paper studies the interaction between corruption and relative factor abundance on the trade openness of countries. The motivation follows from the stylized fact that the share of international trade in the Gross Domestic Product (measured by Trade-GDP ratio) for the low income (labor-abundant) countries is substantially smaller in comparison to the high income (capital-abundant) countries. If greater trade openness benefits the low-income countries more than the high-income countries as argued by Rassekh (2007) among others, what prevents the former from participating in greater international trade? In order to explain this, we introduce corruption in the neoclassical theory of international trade to understand how it affects the comparative advantage of countries, and the resulting pattern of international trade. We view corruption mainly as a
labor-intensive activity that distorts relative factor endowments. The idea is based on Bhagwati (1982) where corruption has been described as a directly unproductive profit seeking (DUP) activity. Our theoretical framework illustrates situations under which corruption can have different implications on trade between countries based on the relative degrees of corruption in the labor-abundant and the capital-abundant countries. We also discuss a scenario when corruption can act as a source of comparative advantage (or lack thereof) in the presence of similarity of relative factor endowments across countries in the Heckscher-Ohlin (H-O) framework, and can promote trade. Finally, we empirically investigate if the effect of corruption on trade openness depends on factor abundance by using cross-country time series data on trade openness, corruption, and capital-labor ratio and by applying estimation techniques developed for dynamic panels. Thus the current paper adds to the literature on the effect of corruption on the trade openness of countries, and provides an alternative explanation on the prevalence of reduced trade openness in the low-income (labor-abundant) countries compared to the high-income (capital-abundant) countries.

Existing literature on the impact of corruption on trade has traditionally viewed this issue in the form of bribes taken by government officials at the border. This increases the transactions costs of doing business and adversely affects trade. Given that the low-income countries generally have more business regulations compared to the high-income

---

1 Of course, our view of corruption being labor-intensive does not imply that corrupt activities do not involve any capital in the process. The point is that the kind of corrupt activities conceived of in this paper e.g. acting as intermediaries (these individuals are commonly referred to as the "dalaals" in India) between the businesses and the bureaucrats necessarily involve substantially more labor than capital.

2 The effect is perceived to be especially strong in the tradable goods sector due to licenses and permits that are required to carry out export-import activities.
countries, higher levels of corruption in these countries translate to lower levels of trade openness. Kaufmann and Wei (1999) found that firms paying bribes were more likely to spend greater management time with bureaucrats negotiating regulations, i.e. corruption seemed to increase bureaucratic restrictions that in turn would adversely affect trade. Anderson (2000) underscored the importance of accounting for transactions costs to explain the problem of “missing trade”, i.e. actual trade volumes between countries are found to be less than that predicted by the standard models in international trade. Subsequently, Anderson and Marcoullier (2002) viewed corruption and lack of contract enforcement as components of transactions costs that raised insecurity in international transactions, and resulted in lower trade between developed and developing countries. Their empirical results indicated strong institutions to be crucial for the growth of trade. In the same lines, de Groot et al. (2004) reported that lower levels of corruption increased bilateral trade. Dutt and Traca (2010) examined the interaction between corruption and tariff barriers on bilateral trade. However, these papers do not discuss the possibility for the effect of corruption on openness to depend on factor endowments (or country incomes).

The paper is organized as follows: section 2 introduces the benchmark model and the main theoretical propositions, section 3 discusses the data sources and the summary statistics, section 4 introduces the econometric model used in the study, section 5 reports the regression results, and section 6 discusses the robustness checks. Section 7 concludes the paper.
2. Benchmark model

We present a variant of the standard Jones (1965) 2x2 neoclassical general equilibrium model. We assume that the global economy is made up of two countries: home country \((H)\) and foreign country \((F)\). \(H\) is a perfectly competitive open economy producing two tradable goods: capital-intensive good \(X\), and labor-intensive good \(Y\). Both \(X\) and \(Y\) exhibit constant returns to scale and diminishing marginal productivity. The major part of the labor supply is involved in producing \(X\) and \(Y\), while the rest of the workers provide the service of circumventing the various institutional complexities involved in international trade. These institutional complexities give rise to corruption. Let \(Z\) represent the corruption-prone sector and \(L_z\) denote the individuals engaged in corrupt activities. Suppose, \(\alpha \in [0,1]\) denote the fraction of each of \(X\) and \(Y\) lost due to corruption. Thus, \(\alpha(P_X X + P_Y Y)\) represents the maximum total value of the goods that can be spent on those who are in a position to manipulate the system and recover the booty. We assume competitive market conditions for corruption in order to be consistent with the otherwise standard specifications of the competitive general equilibrium model. Let \(Y\) be the numeraire good and \(P_X = P\).

Then, under perfect competition in the labor market: \(\alpha(PX + Y) = wL_z\) \((1)\) where, \(w\) is the market-clearing wage rate, and \(\alpha\) is the indicator of institutional quality. Higher values of \(\alpha\) indicate greater corruption and poorer institutions.

Zero-profit conditions in the two sectors can be expressed as:

\[
wa_L + ra_K = P(1 - \alpha) \tag{2}
\]

\[
wa_L + ra_K = (1 - \alpha) \tag{3}
\]
where, $a_{Li}, a_{Ki} \ (i = X, Y)$ denote the technological coefficients, and $r$ denotes the return on capital.

Full employment conditions for $X$ and $Y$ respectively can be expressed as:

$$a_{xX}X + a_{yY}Y = \bar{L} - L_z \quad (4)$$
$$a_{xX}X + a_{yY}Y = \bar{K} \quad (5)$$

where, $\bar{L}$ and $\bar{K}$ denote the labor and capital endowments in the home country, and $L_z$ denote the amount of labor engaged in corrupt activities. On the demand side, we assume a homothetic demand function: $\frac{X_d}{Y_d} = f(P), f'(P) < 0 \quad (6)$

where $X_d$ and $Y_d$ denote the quantities demanded.

Given $\alpha$, $P_x$ and $P_y$, the equilibrium values for $w$ and $r$ can be solved from equations (2) and (3). Starting from any $L_z$ such that $(\bar{L} - L_z) > 0$, and for any given $(w, r)$ and $(a_{Li}, a_{Ki})$, we can solve for equilibrium values of $X$ and $Y$ from (4) and (5).

The equilibrium level of $L_z$ can be obtained from equation (1).\(^3\)

In order to analyze the effect of $\alpha$ on effective factor abundance and thereby on the autarkic relative price level (that determines the volume of trade between countries), we introduce $F$ in the model. While both $H$ and $F$ are assumed to be otherwise similar in technology and preference, they are assumed to differ in their factor endowments. Let $F$ be relatively capital-abundant, such that $(\bar{K} / \bar{L})^F > (\bar{K} / \bar{L})^H$.

\(^3\) Note that sector $Z$ enters as a non-traded sector in the 2x2 H-O setup. Activity in sector $Z$ thus becomes complementary to $X$ - the capital-intensive sector, as $Z$ turns out to be highly labor-intensive.
Case A: Suppose the foreign country is corruption-free such that \( \alpha^r = 0 \).

For simplicity, we assume that initially \( \alpha^H = 0 \) and then corruption increases in \( H \) possibly due to institutional problems. From equations (2) and (3), given \( P \), there will be a symmetric response in both the price equations such that \( \hat{w} = \hat{r} < 0 \), i.e. there will be a simultaneous reduction in both \( w \) and \( r \). Given equation (1), this implies that there will be an increase in labor supply in the corrupt sector \( Z \) that is diverted away from the production of both \( X \) and \( Y \), i.e. \( L_z \) increases (\( \hat{L}_z > 0 \)). Since \( X \) is capital-intensive and \( Y \) is labor-intensive, due to Rybczynski effect, there will be a relatively larger (negative) impact on the production of \( Y \) (compared to \( X \)) such that the relative supply of the capital-intensive commodity \( X \), i.e. \( (X/Y) \) increases in \( H \). This reduces the gap between \( (X/Y)^H \) and \( (X/Y)^F \) for any given \( P \). Thus the autarkic relative price gap \( (P_A^H - P_A^F) \) (where “A” denotes autarky) reduces thereby reducing trade between \( H \) and \( F \).

An increase in \( \alpha^H \) in \( H \) weakens its effective labor supply. Since corruption has been assumed to be a relatively labor-intensive activity, the labor-abundant country suffers in the production of the good over which it has comparative advantage. Thus the corruption-induced bias works against its relative factor endowment in the labor-abundant country.

Case B: Suppose the home country is corruption-free such that \( \alpha^H = 0 \) and there is an increase in corruption in the capital-abundant country such that \( \alpha^F > 0 \).

In this case, corruption will reinforce the effective capital supply in the capital-abundant country and further increase the difference between the relative factor endowments between \( H \) and \( F \). By the Rybczynski theorem, this would increase the production of \( X \) and reduce the production of \( Y \) thereby reducing the relative price of \( X \) in \( F \). Thus the
autarkic price gap increases between the two countries and increases the possibility of trade.

**Case C:** Suppose, both $\alpha^H > 0$, $\alpha^F > 0$ and $\alpha^H > \alpha^F$, i.e. the labor-abundant home country ($H$) is more corrupt than the capital-abundant foreign country ($F$).

In this situation, while corruption artificially makes the capital-abundant country even “more capital-abundant”, it induces the labor-abundant country to behave in a “less labor-abundant” manner away from its natural comparative advantage. The resulting similarity in the effective factor endowments in the two countries reduces the autarkic relative price difference in the two countries and reduces the level of trade.

**Proposition 1:** *Ceteris paribus, labor-abundant country’s relative factor endowment is mitigated by corruption, whereas it is further strengthened in the capital-abundant country.*

\[
\hat{P} = \frac{-\psi[(\hat{K} - \hat{L}) + \lambda L_d \alpha]}{\sigma_d + \psi \lambda L_d [\lambda + \theta]} \tag{8}
\]

Proof: See appendix for a detailed mathematical proof. A closer look at equation (8) reveals that an increase in the labor supply $L$ in $H$ (the labor-abundant country) will increase $P$ i.e. the relative price of the capital-intensive good $X$, (i.e. reduce the relative price of the labor-intensive good $Y$) thereby increasing trade between the two countries according to the H-O model. On the other hand, an increase in $\alpha$ (as in **Case A**) will reduce $P$ thereby reducing trade between the two countries. This happens because corruption draws labor into the sector involved in corrupt activities. This diversion has an impact on comparative advantage and on relative price in a direction that is opposite to the factor endowment of a country.
The same reasoning also ensures that greater corruption as well as an increase in capital endowment will have the same impact on the relative price. Thus even without any change in the labor and capital endowments, trade between $H$ and $F$ can change only due to a change in the degree of corruption between the two countries. This leads us to the following corollary:

**Corollary 1:** If the two countries have similar relative factor endowments, trade will be determined by the relative degree of corruption between the two countries.

$$\Delta \hat{P} = (-) \frac{\psi[Z_0 \Delta d\alpha]}{\sigma_d + \psi \hat{\lambda}_z [\lambda + \theta]}$$ (9)

Proof: See appendix A for the detailed mathematical proof. Similar factor endowments in the two countries imply identical relative prices as the technology of production (and preferences) have been assumed to be similar across nations—thus there should not be any trade by the H-O model. However, if one country is corruption-ridden and the other is not (or if the degree of corruption is substantially different), then relative prices will be different and trade would take place. The main reason behind this trade is that the intermediation-related corrupt activities are labor-intensive. Corruption lowers the effective labor supply such that the amount of productive labor endowment gets smaller and this has a bearing on the relative prices and trade pattern.

3. Econometric model

Any impact of corruption on trade openness in our theoretical model works through factor endowments. *A priori*, we do not know whether the relationship is

---

4 Note that substituting for $\hat{L} = \hat{K} = 0$ in (8), $\hat{P} = (-) \frac{\psi[Z_0 d\alpha]}{\sigma_d + \psi \hat{\lambda}_z [\lambda + \theta]}$. 

8
conditional on the level of factor abundance of countries or for what level of capital-labor ratio, the relationship between corruption and openness changes sign. The following specification addresses both these problems:

$$ y_{it} = \alpha y_{it-1} + \beta_1 \text{Corruption}_{it} + \beta_2 \text{Corruption}_{it} \times (K/L)_{it} + \beta_3 (K/L)_{it} + \mu_t + \tau_j + \nu_{it} \tag{10} $$

where, $y_{it}$ is the measure of trade openness in country $i$ at time $t$; $\text{Corruption}_{it}$ is a measure of the corruption level in country $i$ at time $t$; $(K/L)_{it}$ is the capital-labor ratio in country $i$ at time $t$; $\mu_t$-s are time-invariant country fixed effects possibly correlated with the explanatory variables; $\tau_j$- year fixed effects; and $\nu_{it}$ is the idiosyncratic error term.

From (10), the marginal effect of corruption on trade openness is $\beta_1 + \beta_2 (K/L)_{it}$. For a labor-abundant country, $(K/L)$ is small and the sign of the marginal effect of corruption is likely to be driven by $\beta_1$. On the other hand, for a capital-abundant country, $(K/L)$ is large, and the sign of the marginal effect of corruption will be driven by $\beta_2$. If greater corruption is associated with lower (/greater) trade openness in the labor-abundant countries and greater (/lower) trade openness in the capital-abundant countries, then the statistical priors are $\beta_1 < 0$ (/$\beta_1 > 0$) and $\beta_2 > 0$ (/$\beta_2 < 0$). The critical capital-labor ratio at which the impact of corruption on trade openness changes from negative to positive can be obtained from our regressions as $-(\beta_1 / \beta_2)$. Also, if the model is properly specified, the critical capital-labor ratio obtained from the regressions should lie between its maximum and minimum values in the sample.

Identifying the causal impact of explanatory variables on trade openness in a non-experimental setting can lead to severe endogeneity problems, either (a) due to systematic measurement error of corruption and capital-labor ratio; or (b) omitted variable bias due
to non-inclusion of relevant explanatory variables; or (c) reverse causality from trade openness to the explanatory variables, or (d) all the above. Any of these problems would render the estimates of the explanatory variables to be biased and inconsistent.\(^5\) The dynamic panel specification adopted in equation (10) is designed to address the econometric problems induced by unobserved country-specific effects and joint endogeneity of the explanatory variables in lagged dependent variable models. They are especially suited if the number of time periods is small as in our case.

4. Data sources and summary statistics

For trade openness, we use the yearly Trade/GDP measure available from the World Development Indicators (WDI) 2009 CD-ROM.\(^6\) The capital-labor ratio measure has been constructed by dividing the comprehensive measure of capital stock available for each country every year by the size of its labor force, both obtained from the WDI. The capital stock measure is the real value of gross fixed capital formation that includes land improvements, plant, machinery, and equipment purchases; construction of roads, railways, schools, offices, hospitals, private residential dwellings, commercial and

---

\(^5\) Potentially, these problems can be addressed by using proper instrumental variables for corruption and/or capital-labor ratio if they are suspected to be endogenous. However, it is notoriously difficult to find suitable instruments for corruption in equations of trade openness, since some of the commonly used instruments (e.g. colonial origin, ethno-linguistic fractionalization index, etc.) have been either found to affect the trade levels of countries, and thereby do not satisfy the over-identifying restrictions, or in some situations have been found to be weakly correlated with corruption.

\(^6\) The share of international trade in the total income is an admittedly imperfect measure of trade openness. Nevertheless it is widely used as an indicator of openness (or absence of trade barriers) in the empirical trade literature because the measure is found to be negatively correlated with measures of trade protection like import tariffs, import quotas, or non-tariff barriers across countries. For our purposes, given that the theoretical model suggests corruption to affect openness, we use Trade/GDP as the dependent variable in our regressions instead of the trade policy measures.
industrial buildings calculated in constant 2000 US dollars. The corruption measure is the widely used International Country Risk Guide’s (ICRG) index for bureaucratic corruption, available for over 100 countries during 1982-1997. Corruption is measured on a 0 - 6 scale with higher values denoting lower corruption- for easier interpretation, we rescaled the measure such that higher values of the index denote greater corruption. The dataset has a maximum of 1368 observations for all variables during the period 1982-1997. The panel is unbalanced since we have more observations for some countries than others.

Tables 1a and 1b respectively present the descriptive statistics and the correlations between corruption and (logarithms of) Trade/GDP, capital-labor ratio, and per capita real income (also obtained from the WDI). There is a wide variation in Trade/GDP in the sample, with Hong Kong being the most open economy having a trade share of about 294% of its GDP, while Ghana is the least open economy having a trade share of only 6% during 1982-1997. Logarithm of capital-labor ratio ranges from a minimum of 2.16 (an absolute value of $8.67 per person) in Zaire to a maximum of 9.88 (an absolute value of $19,535 per person) in Luxembourg. We note that per capita income and capital-labor ratio are almost perfectly correlated (r = 0.97) so that the capital-abundant countries are also the high-income developed countries in the sample. High income (capital-abundant) countries like Luxembourg, Sweden, Finland, Netherlands, France etc. seem to experience very low levels of corruption (recording scores of ICRG index = 0) while low income (labor-abundant) countries like Bangladesh and Zaire record very high levels of corruption (scores of ICRG index = 6) over a number of years. Across countries,

\footnote{Our regressions are based on a maximum of 98 countries for which data on all explanatory variables are available throughout this period.}
Corruption seems to be more of a problem with the labor-abundant countries since it is found to be negatively correlated with both the capital-labor ratio \( (r = -0.63) \) and the per capita income \( (r = -0.67) \). In general, high-income capital-abundant countries are found to possess higher levels of trade openness with both the capital-labor ratio and per capita real income being positively correlated with the trade-GDP ratio.

Figures 1(a) and 1(b) are scatter plots depicting the impact of corruption (measured by the ICRG index on the x-axis) on trade openness of countries (measured by \( \log(\text{Trade/GDP}) \) on the y-axis) with capital-labor ratio< 5.69 (first quartile) and those with capital-labor ratio> 8.39 (fourth quartile), i.e. countries with extremely low and extremely high levels of capital-labor ratio. The charts suggest that the effect of corruption on Trade/GDP is different between the two groups of countries. While figure 1(a) suggests a clear negative impact of corruption on openness, there does not seem to be any discernible impact on openness as shown in figure 1(b). Trade openness is found to be (strongly) negatively associated with corruption (at 1% level of significance) for the highly labor-abundant countries, while corruption is found to be (statistically) not significant as an explanatory factor for openness in the latter group of highly capital-abundant countries (absolute value of t-statistic = 0.93).

---

8 Another stylized fact, irrespective of the source and type of corruption data, is that labor-abundant (low-income) countries generally experience higher corruption levels in comparison to the capital-abundant (high-income) countries. One possible explanation for this phenomenon might be that the labor-abundant countries usually have more bureaucratic regulations and red tapes that create greater opportunities for rent seeking. For many developing countries in South Asia or Latin America, the bureaucratic systems are vestiges of the import-substituting industrialization (ISI) development paradigm that they had adopted as an alternative to the free market based economic model in the post-World War II era. The type of corruption conceived of in this paper thus would attract workers, who, instead of working in the productive sectors will act as intermediaries between the bureaucrat and the private producer, say, in order to procure a permit or license.
5. Regression results

We start with the classical OLS estimator and modify it step-by-step to address the endogeneity issues and other econometric concerns. First, we regress Trade/GDP only on corruption and capital-labor ratio in order to detect the impact of corruption on openness. As reported in column (a) of table 2, corruption is found to be statistically not significant. The estimated residuals are found to be persistently correlated across different time periods. In the presence of autocorrelation, our estimates are biased and inconsistent. Moreover, this specification cannot comment as to how the relationship between openness and corruption depends on factor abundance. Thus we re-run the regression by including the interaction term between corruption and capital-labor ratio (without the country fixed effects) as an additional explanatory variable. The results reported in column 2(b) suggests an asymmetric effect of corruption on openness across countries, since the coefficient associated with corruption ($\beta_1$) is negative and statistically significant, while the coefficient for the interaction term ($\beta_2$) is positive and statistically significant. More specifically, corruption seems to be associated with reduced openness in the labor-abundant countries and greater openness in the capital-abundant countries. However, this empirical specification is probably mis-specified since the critical value of the capital-labor ratio obtained from this regression exceeds its maximum possible value in the sample (i.e. $10>9.88$). Thus we have reasons to doubt the validity of these results and suspect endogeneity problems. As a first pass, we run a fixed effect (FE) regression incorporating both the country and year dummies in the previous specification. Based on the results reported in column 2(c), once again we find strong evidence of the

---

9 We have not reported the serial correlation of the residual error terms and these can be obtained from the authors on request.
negative impact of corruption on openness in the labor-abundant countries and a positive impact on openness in the capital-abundant countries. The critical level of capital-labor ratio separating the labor-abundant and the capital-abundant countries (log(K/L) = 6) also lies within the permissible range of values in the sample.

Finally, we implement the Generalized Method of Moments (GMM) estimator for dynamic panels developed by Arellano and Bond (1991) in our preferred specification in equation (10). Consistent estimation is obtained by first differencing (10) and then implementing the two-stage least squares (2SLS) estimator with instrumental variables that are correlated with the suspected endogenous variables but orthogonal to \( \Delta v_{it} \). The instrumental variables thus generated are internal to the data and are obtained from the lagged values of the explanatory variables and the lagged dependent variable.

For consistent estimation of (10), an important assumption that needs to be satisfied is that there is no second-order serial correlation of the idiosyncratic error terms \( \nu_{it} \). We treat the explanatory variables (corruption, corruption x (K/L), (K/L)) to be weakly exogenous (i.e. correlated with the present and the past values of the error term, but uncorrelated with future values of \( \nu_{it} \)) as well as strictly endogenous (i.e. always correlated with \( \nu_{it} \)). The estimator based on these conditions is referred to as the difference GMM estimator. All regressions control for year and country fixed effects.\(^{10}\)

\(^{10}\) Roodman (2009a) suggests using the orthogonal deviation form of the estimator proposed by Arellano and Bover (1995) for unbalanced panels as is the case with our sample. In order to address the problems that arise with the proliferation of instruments in GMM estimation as discussed in Roodman (2009b), we use one period lag for the predetermined explanatory variables and the endogenous lagged dependent variable as instruments. To control for heteroscedasticity, we implement the two-step robust estimator. We also implement a finite sample correction to the two-step covariance
The results are reported in columns (e) and (f) in table 2. The lagged value of \( \log(\text{Trade}/\text{GDP}) \) is found to be highly significant in both specifications (at 1% level) so that not including the lagged openness term in the previous regressions possibly led to severe omitted variable bias. Corruption and the interaction term are found to be moderately significant with \( \beta_1 < 0 \) and \( \beta_2 > 0 \). The p-values associated with the Hansen test statistic indicate that the null hypothesis that the instrument set is exogenous is not rejected in both the regressions. The Arellano-Bond test for first-order serial correlation in the error term (i.e. second order serial correlation in the differenced error term \( \Delta \nu_t \)) is also satisfied since the null hypothesis of no serial correlation is not rejected based on its p-values in both cases.\(^{11}\) The critical capital-labor ratio in these two specifications [i.e. 8.5, 9] suggests that corruption hurts trade openness in the majority of the countries in the sample, and that it has a moderately positive influence on openness for a small number of capital-abundant countries. It is to be noted that a similar message was also conveyed in figures 1(a) and 1(b) where corruption was found to be negatively associated with openness in the highly labor-abundant countries and did not have a statistically significant impact on openness in the highly capital-abundant countries.

\(^{11}\) We also ran the difference GMM regression by treating our major explanatory variables as strictly exogenous. The results reported in column 2(d) suggest that the null hypothesis of exogeneity of the instruments is rejected on the basis of the p-value of a significant Hansen test statistic. Moreover, this specification yields an implausible critical capital-labor ratio that lies outside its possible range in the sample. This suggests that it is important to treat the explanatory variables as endogenous in our trade openness equations.
6. Robustness checks

We perform a number of checks in order to test the robustness of the results and crucially, to check for the validity of the instrument set. First, we control for country size in the GMM regression by using the (logarithm of) population available from the WDI as an additional explanatory variable. The level of political rights has been dubbed as an important predictor for trade openness in that democratically elected governments usually allow more trade in comparison to dictatorships (Dutt and Mitra, 2002). To this end, a measure of political rights obtained from Freedom House is introduced in the regressions. We also introduce a dummy variable indicating whether a country is a member of the GATT or the WTO in the regressions, to find out if the hypothesized relationship between openness and corruption is suspect to membership in multilateral organizations across countries. The GATT/WTO dummy is created on the basis of data on memberships available from the WTO website (www.wto.org). In all the regressions, we consider our explanatory variables of interest to be strictly endogenous on the basis of results of the Hansen test obtained in the previous section. The results for the difference GMM regressions reported in columns (a), (b), (c) in table 3 indicate that the inclusion of the controls does not impact our hypothesis of the asymmetric relationship between Trade/GDP and corruption across countries. Moreover, based on the signs for $\beta_1$ and $\beta_2$, corruption strongly reduces openness in the labor-abundant countries and increases openness in the capital-abundant countries. While the political rights variable and the GATT/WTO membership dummy are found to be not significant, country size measured by population is found to be negatively related to trade openness and mildly significant,
thereby suggesting that larger countries are usually less open to trade in comparison to the smaller countries as has been reported before (e.g. Alesina and Wacziarg (1998)).

Next, instead of capital-labor ratio, we interact corruption with (the logarithm of) real GDP per capita. This specification allows us to test if the corruption-trade relationship is dependent on the level of economic development. However, without controlling for country size, both corruption and its interaction term with per capita income are found to be statistically not significant as reported in column (d) of table 3. Moreover, this specification yields an implausible critical value of per capita income (log(Real income per capita) = 12) which exceeds the maximum value of per capita real income in the sample (10.52). Thus we re-run our regressions first, by including population and political rights, and finally, including all the three controls (i.e. population, political rights, and the GATT/WTO dummy). The results reported in columns (e) and (f) suggest that inclusion of the controls once again render corruption and the interaction term to be highly significant and uphold the basic theoretical prediction of our model on the asymmetric impact of corruption on openness on labor- and capital-abundant countries. The critical levels of (log of) per capita income obtained from these specifications [8.67, 8.33] are also reasonable as they lie within the range of possible values in the sample [4.31, 10.52]. The instrument set satisfies the exclusion restrictions based on the insignificant p-values for the Hansen test statistic. We also find

---

12 According to the neoclassical production function, per capita income of a country is directly proportional to its capital-labor ratio, and in our sample, per capita GDP is strongly correlated with the capital-labor ratio (about 0.97 in the sample). Thus we anticipate corruption to have a similar asymmetric impact on openness based on the level of development.
that there is no second order serial correlation of the idiosyncratic error terms based on the p-values of the serial correlation test.

7. Conclusion

This paper models corruption as a labor-intensive activity in a simple general equilibrium framework. Using a modified HOSV framework, the major theoretical conclusion is that the impact of corruption on trade between countries depends on their levels of factor endowments. It is however important to note that in the real world, trade volumes are likely to be influenced by other determinants of openness or trade policy barriers (e.g. due to other factors or considerations that we have not included in our analysis). We have attempted to control for these unobserved heterogeneity in the data by using country and year fixed effects in the regressions. We have addressed the endogeneity problems in the regressions by implementing robust dynamic panel estimators. Our empirical results suggest that consistent with the theoretical predictions, \textit{ceteris paribus}, corruption has an asymmetric effect on trade openness between labor-abundant countries and capital-abundant countries. Moreover, greater corruption reduces the share of trade in total income for the low-income labor-abundant countries and increases the trade share in case of high-income capital-abundant countries. Our results thus contribute to explanations on the stylized fact of lower Trade/GDP measures in the former group of countries. The results remain robust to the inclusion of relevant controls as well as using alternate measures of relative factor endowments.
Appendix: Mathematical proof

Differentiating and manipulating equations (2) and (3) we get, \( \hat{w}(-\theta) + \hat{r}d\theta = \hat{P} \)

where \( \theta = \begin{pmatrix} \frac{\partial k_y}{\partial k_x} & \frac{\partial k_y}{\partial k_x} \\ \frac{\partial k_x}{\partial k_x} & \frac{\partial k_x}{\partial k_x} \end{pmatrix} = (\theta_{kX} - \theta_{kY}) = (\theta_{LY} - \theta_{LX}) \), and \( \theta_{Li}(\theta_{Ki}) \) denote the value share of \( L/K \) in the \( i \)-th commodity, \( i = X, Y \).

Thus, \( \hat{w} - \hat{r} = \frac{\hat{P}}{\theta} \) where \( \theta > 0 \) since \( X \) is capital-intensive

Solving for \( \hat{w} \), we get \( \hat{w} = \hat{P} \left[ 1 - \frac{\theta_{kX}}{\theta} \right] = -\theta\hat{P} \), where \( (-\theta) = \left[ 1 - \frac{\theta_{kX}}{\theta} \right] < 0 \) \( \text{(A)} \)

Differentiating and manipulating equations (4) and (5) we get,

\( (X - Y) = \psi(\hat{K} - \hat{L}) + \psi\hat{L}_x\hat{L}_z \), where \( \psi > 0 \) (due to Rybczynski effect) \( \text{(B)} \)

Totally differentiating equation (1), with initial \( \alpha = 0 \), we obtain

\( d\alpha + \lambda\hat{P} = \hat{w} + \hat{L}_x \), where \( \lambda = \frac{PX}{PX + Y} \) (\( = \) share of \( X \) in national income) \( \text{(C)} \)

From (C) and (A), \( \hat{L}_x = d\alpha + \hat{P}(\lambda + \theta) \) \( \text{(D)} \)

From equation (6),

\( \hat{X}_d - \hat{Y}_d = -\sigma_d\hat{P} \) where \( -\sigma_d = \) price elasticity of demand of \( X \) \( \text{(6a)} \)

Using (B), (D) and (6a),

\( \hat{P} = (-)\frac{\psi(\hat{K} - \hat{L})}{\sigma_d + \psi\hat{L}_z} [\lambda + \theta] \) \( \text{(Q.E.D.)} \) \( \text{(8a)} \)

Thus the difference in autarkic price level relative to benchmark no-corruption level is given by, \( \Delta\hat{P} = (-)\frac{\psi\hat{L}_z\Delta d\alpha}{\sigma_d + \psi\hat{L}_z[\lambda + \theta]} \) \( \text{(Q.E.D.)} \) \( \text{(9a)} \)
References


Kaufmann, Daniel, and Shang-Jin Wei, “Does ‘grease money’ speed up the wheels of commerce?” *International Monetary Fund Working papers* 00/64 (1999).


Table 1a: Openness, Corruption, and Capital-labor ratio:
Summary statistics (1982 - 1997)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observations</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>log(Trade/GDP)</td>
<td>1368</td>
<td>4.04</td>
<td>0.55</td>
<td>1.84</td>
<td>5.68</td>
</tr>
<tr>
<td>log(K/L)</td>
<td>1368</td>
<td>6.93</td>
<td>1.62</td>
<td>2.16</td>
<td>9.88</td>
</tr>
<tr>
<td>Corruption</td>
<td>1368</td>
<td>2.41</td>
<td>1.48</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Log(Real income per capita)</td>
<td>1368</td>
<td>7.65</td>
<td>1.62</td>
<td>4.31</td>
<td>10.52</td>
</tr>
</tbody>
</table>

Table 1b: Openness, Corruption, and Capital-labor ratio:
Correlations (1982 - 1997)

<table>
<thead>
<tr>
<th>log(Trade/GDP)</th>
<th>log(K/L)</th>
<th>Corruption</th>
<th>log(Real income per capita)</th>
</tr>
</thead>
<tbody>
<tr>
<td>log(Trade/GDP)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(K/L)</td>
<td>0.28</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Corruption</td>
<td>-0.2</td>
<td>-0.63</td>
<td>1</td>
</tr>
<tr>
<td>log(Real income per capita)</td>
<td>0.25</td>
<td>0.97</td>
<td>-0.67</td>
</tr>
</tbody>
</table>
Table 2: Dependent variable- log(Trade/GDP) Regression results (1982 - 1997)

<table>
<thead>
<tr>
<th></th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
<th>(e)</th>
<th>(f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log(Trade/GDP)</td>
<td>0.87***</td>
<td>0.65***</td>
<td>0.62***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(T-1)</td>
<td>0.62***</td>
<td>0.35***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Corruption</strong></td>
<td>-0.01</td>
<td>-0.10**</td>
<td>-0.18***</td>
<td>0.01</td>
<td>-0.17*</td>
<td>-0.18#</td>
</tr>
<tr>
<td>**Corruption X log(K/L)</td>
<td>0.01*</td>
<td>0.03***</td>
<td>-0.001</td>
<td>0.02*</td>
<td>0.02*</td>
<td></td>
</tr>
<tr>
<td>Log(K/L)</td>
<td>0.09***</td>
<td>0.06***</td>
<td>0.06*</td>
<td>-0.03</td>
<td>-0.23**</td>
<td>-0.21**</td>
</tr>
<tr>
<td>Critical (K/L)</td>
<td>10</td>
<td>6</td>
<td>10</td>
<td>8.5</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1,368</td>
<td>1,368</td>
<td>1,368</td>
<td>1,170</td>
<td>1,170</td>
<td>1,170</td>
</tr>
<tr>
<td>Country Fixed Effects</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No. of countries</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>No. of instruments</td>
<td>31</td>
<td>56</td>
<td>56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hansen test p-value</td>
<td>0.08*</td>
<td>0.69</td>
<td>0.58</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second order</td>
<td>0.56</td>
<td>0.52</td>
<td>0.53</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>correlation test p-value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Robust t-statistics in brackets

*** p<0.01, ** p<0.05, * p<0.1, # p<0.15
Table 3: Dependent variable - log(Trade/GDP)  
Regression results (1982 - 1997)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>log(Trade/GDP) (T-1)</td>
<td>0.48***</td>
<td>0.49***</td>
<td>0.50***</td>
<td>0.68***</td>
<td>0.52***</td>
</tr>
<tr>
<td></td>
<td>[3.16]</td>
<td>[4.40]</td>
<td>[4.40]</td>
<td>[4.37]</td>
<td>[4.18]</td>
</tr>
<tr>
<td>Corruption</td>
<td>-0.30**</td>
<td>-0.29***</td>
<td>-0.28***</td>
<td>-0.12</td>
<td>-0.26**</td>
</tr>
<tr>
<td></td>
<td>[-2.12]</td>
<td>[-2.76]</td>
<td>[-2.69]</td>
<td>[-0.81]</td>
<td>[-2.14]</td>
</tr>
<tr>
<td>Corruption X log(Real GDP per capita)</td>
<td>0.01</td>
<td>0.03**</td>
<td>0.03*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.79]</td>
<td>[2.03]</td>
<td>[1.98]</td>
<td></td>
</tr>
<tr>
<td>log(Real GDP per capita)</td>
<td>-0.07</td>
<td>-0.25</td>
<td>-0.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-0.31]</td>
<td>[-0.98]</td>
<td>[-0.87]</td>
<td></td>
</tr>
<tr>
<td>Corruption X log(K/L)</td>
<td>0.04**</td>
<td>0.04***</td>
<td>0.04***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[2.07]</td>
<td>[2.73]</td>
<td>[2.68]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(K/L)</td>
<td>-0.28***</td>
<td>-0.25**</td>
<td>-0.24**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-2.84]</td>
<td>[-2.23]</td>
<td>[-2.01]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical (K/L)</td>
<td>7.5</td>
<td>7.25</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Real GDP per capita</td>
<td>12</td>
<td>8.67</td>
<td>8.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1,170</td>
<td>1,163</td>
<td>1,163</td>
<td>1,170</td>
<td>1,163</td>
</tr>
<tr>
<td>No. of countries</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Country Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No. of instruments</td>
<td>56</td>
<td>70</td>
<td>70</td>
<td>56</td>
<td>70</td>
</tr>
<tr>
<td>Hansen test p-value</td>
<td>0.57</td>
<td>0.35</td>
<td>0.28</td>
<td>0.47</td>
<td>0.55</td>
</tr>
<tr>
<td>Second order serial correlation test p-value</td>
<td>0.61</td>
<td>0.56</td>
<td>0.55</td>
<td>0.64</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Robust t-statistics in brackets  
*** p<0.01, ** p<0.05, * p<0.1, # p<0.15
Trade Openness and Corruption- labor abundant

\[ \text{log(trade/gdp)} = -0.10 \times \text{Corruption} + 4.14, \text{ R-squared}=0.05 \]

\[ t\text{-stat(abs)} = 4.38 \]  

Figure 1(a)

Trade Openness and Corruption- capital abundant

\[ \text{log(trade/gdp)} = -0.03 \times \text{Corruption} + 4.24, \text{ R-squared}=0.002 \]

\[ t\text{-stat(abs)} = 0.93 \]

Figure 1(b)