Corruption and Openness*

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Abstract

We report an intriguing empirical observation. The relationship between corruption and output depends on the economy's degree of openness: in open economies, corruption and GNP per capita are strongly negatively correlated, but in closed economies there is no relationship at all. This stylized fact is robust to a variety of different empirical specifications. In particular, the same basic pattern persists if we use alternative measures of openness, if we focus on different time periods, if we restrict the sample to include only highly corrupt countries, if we restrict attention to specific geographic areas or to poor countries. We find that it is primarily the degree of financial openness that determines whether corruption and output are correlated. Moreover, corruption is negatively related to capital accumulation in open economies, but not in closed economies. We present a model, consistent with these findings, in which the main channel through which corruption affects output is *capital drain*.

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1 Introduction

Economists, historians, and political scientists have long been engaged in a debate as to whether, and to what extent, corruption harms economic growth. The prevailing view is that corruption disrupts economic activity by distorting the efficient allocation of resources in the economy. Perhaps surprisingly, some have argued that, by 'oiling the wheels' of bureaucracy, corruption can also sometimes be beneficial for the economy (Huntington, 1968; Lui, 1985).[1]

In an important recent contribution to this debate, Mauro (1995) constructed a corruption index for 67 countries, and showed that corruption is indeed negatively associated with investment and growth. Mauro also argued that the direction of causality is from corruption to development, rather than vice-versa.[2] A number of theoretical studies point to several channels through which corruption may adversely affect income, but as of yet, these theoretical investigations, although suggestive, lack an empirical basis.[3]

This paper contributes to the literature on corruption by reporting an intriguing stylized fact which seems to have escaped the attention of researchers. We find that the relationship between corruption and output per capita is strongly related to a country's degree of openness. Figure 1 presents a scatter plot of log GDP per capita in the 1996-2003 period on an index of corruption for open countries (top panel) and closed countries (bottom panel).[4] It is immediately apparent that output per capita is strongly negatively correlated with corruption in open economies (Figure 1a). The relationship between corruption and output per capita among closed economies is more complex: first, the scatter plot has a cloud-like shape, with two countries that stand out as outliers, Estonia and the Democratic Republic of the Congo (formerly Zaire). Second, a closer look at the figure reveals that the points on the scatter plot are clustered by continents: European countries are mostly located in the top left corner of the graph, African countries are located in the bottom right corner, and Asian countries are somewhere in the middle. The negative relationship between output and corruption thus masks what is essentially a continent effect. In the empirical section of the paper we show that, controlling for continent dummies, the relationship between corruption

[1] By contrast, Tanzi (1998) and Guriev (2004) claim that corruption can generate an excessive amount of red tape.

[2] Mauro's findings have been confirmed in recent work by Kaufmann, Kraay and Mastruzzi (2003). These findings are consistent with those of Hall and Jones (1999) and La Porta et al. (1999).

[3] See, e.g., the recent surveys by Bardhan (1997), Jain (2001), and Aidt (2003), and the references therein.

[4] The corruption index is taken from Kaufmann, Kraay and Mastruzzi (2003). Countries are classified as open or closed based on the Wacziarg and Welch (2003) openness index. A detailed description of the sources and the data appears in Section 2 below.

and output disappears in closed countries, while it persists in open ones. To strengthen this point, we look at the relationship between corruption and output separately by continents, and find the same basic pattern: in closed economies – no relationship, in open economies – a strong negative relationship.

A possible explanation for the difference in the corruption-output relationship between open and closed economies is that the sample of closed countries is made up primarily of poor and highly corrupt economies. We check this hypothesis by restricting attention to Africa or Asia alone, to non-OECD countries, and to countries with a high level of corruption. All these different sample restrictions strongly indicate that the difference between open and closed economies does not stem from the fact that closed economies are on average poorer and more corrupt. Similarly, one may argue that corruption is measured imprecisely in poor economies: hence, it will be difficult to detect any correlation between output and corruption simply because of attenuation bias. This is not the case: even when we restrict the sample to countries where corruption is measured with high variability we find a strong positive correlation in the open economies, and no correlation in the closed economies. We also experiment with a variety of different empirical specifications to assess the robustness of our findings. The same basic pattern persists if we focus on different time periods and if we add controls for size, population, latitude, and religion.

We should emphasize that in all of the above we stay away from the issue of the direction of causality between corruption and output. It is striking that there is such a sharp dichotomy between open and closed countries in the *partial correlation* between the two variables, regardless of the direction of causality. Clearly, though, one may also be interested in whether the causal effect of corruption on output differs depending on the country's degree of openness. To address this question, we employ a variety of different instruments for corruption that are commonly used in the literature. The 2SLS estimates confirm that corruption is negatively related to output in open economies, but not in closed economies.

In order to identify the possible causes of this empirical observation we decompose income to gauge whether the reported pattern of results is attributable to physical capital, to human capital, or to total factor productivity (TFP).[5] We find that the results are robust with respect to the replacement of income by physical capital but not with respect to the replacement of income by TFP. That is, while corruption seems to be related to the level of physical capital only in open economies, its relationship with TFP is independent of the economy's degree of openness. Interestingly, when openness is measured either by the vol-

[5] See also Caselli (2004) for an in-depth review of "income accounting."

ume of trade or by the level of barriers to trade, there is no distinction between open and closed countries in the corruption-output relationship. Only when openness is measured by the black market premium, a proxy for free capital movements, do we find that the negative correlation between corruption and output is limited to open economies.

We present a simple neoclassical growth model with endogenous corruption that is consistent with the three key stylized facts that emerge from the empirical analysis: (1) corruption is negatively correlated with output in open economies, but not in closed economies; (2) the difference between closed and open economies is mainly due to the different effect of corruption on capital accumulation in closed and open economies, respectively; and (3) the extent to which corruption affects output is determined primarily by the degree of financial, rather than trade, openness.

In the model, state officials may steal part of tax revenues which the government uses to finance the provision of a public good. An official that is caught stealing loses his job and with it his wage, which is higher in richer countries. Consequently, in richer countries where public sector wages are higher, officials are less inclined to steal and corruption is lower.[6] Since corrupt officials have an incentive to transfer the proceeds of their illegal activities abroad, corruption depletes the country's capital stock, and slows down economic development. Hence, depending on initial conditions, an economy can either converge to a steady state equilibrium with high wealth and low corruption, or to a steady state equilibrium with low wealth and high corruption. Poor economies are trapped in a vicious circle in which high levels of corruption lead to low output, which generates yet more corruption, and so on.

Our results suggest that an important channel through which corruption impedes economic development is the transfer of illegally obtained capital abroad. Indeed it is estimated that the citizens of some African and Latin American countries hold more financial assets abroad than the entire capital stock in their country (Pastor, 1990; Boyce and Ndikumana 2001). In economies with lower barriers to capital movement, it is easier to transfer illegal graft money abroad. In financially closed economies, illegally obtained capital is more likely to stay within the country. In other words, in open economies corruption affects income by inducing "capital drain." [7] In contrast, in closed economies the adverse effect of corruption

[6] This assumption is supported by Van Rijckeghem and Weder (2001) who find in a sample of low-income countries that the relative pay of civil-servants is negatively associated with corruption.

[7] We use the term *capital drain* to desginate the legal transfer of (legally and ilegally obtained) capital. We distinguish between capital drain and *capital flight* which designates the illegal transfer of (possibly legally obtained) capital.

on output is mitigated because capital drain plays a less important role.

Whether administrative barriers prevent capital flight is related to how the proceeds of corruption are distributed across the ranks of the civil service. For the highest political echelon, barriers to capital flows are irrelevant or ineffective (the late Mobutu of Zaire and Somosa of Nicaragua are infamous examples of rulers who stashed substantial portions of their countries' wealth abroad). Officials at the lower rungs of the bureaucracy probably receive only petty bribes, and are unlikely to transfer money abroad, even in the absence of barriers to capital transfers. However, for those ranked somewhat below the top echelon, restrictions to capital flows can be quite effective. On one hand, these bureaucrats accumulate large enough sums and are sophisticated enough to facilitate transfer of money abroad. On the other hand, they are not influential enough to overcome freely restrictions on capital exports. These bureaucrats will transfer more funds abroad, the lower the administrative barriers. There are reasons to believe that bribes paid to this group are quantitatively important: For example, Hunt and Laszlo (2006) report that judges are involved in only 12 percent of bribery episodes in Peru, but they account for more than 42 percent of the total amount of bribe payments.

Finally, it is important to emphasize that our results should not be interpreted to imply that openness is detrimental to development. To the contrary: our empirical findings indicate that for the majority of countries openness is positively related to output; only in the most corrupt economies do we find that openness and GDP per capita are negatively correlated. Since the most corrupt economies are also the poorest, it follows that openness may be harmful in those economies.[8] This conclusion is corroborated by the findings of Wacziarg and Welch (2003) who showed that openness had beneficial effects in the 1980s but not in the 1990s, when a large number of relatively poor countries opened up.

The rest of the paper proceeds as follows. In the next section, we describe the data we used and the robustness tests we performed. In Section 3 we explore the channels through which corruption may adversely affect output in open economies, but not in closed ones. In Section 4 we present a simple theoretical model that is consistent with our basic empirical findings. Section 5 offers concluding remarks.

[8] This observation is consistent with the recent critique of Rodriguez and Rodrik (2001) of the empirical literature on openness and growth. Our analysis suggests that while openness may indeed be beneficial for rich countries where corruption tends to be low, it may not be the case for very poor countries where corruption is usually much higher.

2 Data and Results

2.1 Data Description

Our main measure of economic development is the 1996-2003 average of GDP per capita in current U.S. dollars evaluated at purchasing power parity, and is taken from the 2004 World Bank Development Index Online. Altogether, GDP per capita is available for 173 countries and dependencies.

As our measure of corruption we use the data set of Kaufmann, Kraay and Mastruzzi (2003, henceforth KKM). KKM use a variety of indicators collected by international organizations, political and business rating agencies, think tanks, and non-governmental organizations to construct six broad aggregates that measure governance from 1996 to 2002. One of these aggregates, which KKM refer to as "Control of Corruption," measures perceptions of corruption. The definition of corruption is the conventional one: the exercise of public power for private gain. The various sources used by KKM examine different aspects of corruption, ranging from "corruption of public officials," "effectiveness of anticorruption initiatives," "corruption as an obstacle to business," "frequency of 'additional payments' to 'get things done,' " "mentality regarding corruption," and the "effect of corruption on the attractiveness of a country as a place to do business." We take as our basic measure of corruption the average of the index in 1996, 1998, and 2000, so that our corruption measure roughly predates our measure of income. The KKM index in each year is standardized so as to have mean zero and standard deviation one in the sample. High values of the index represent good governance, that is, low corruption. We multiply the index by -1 so that, consistent with our terminology throughout the paper, countries with a high value of the corruption variable are indeed more corrupt. Overall, the corruption index is available for 185 countries.

We classify countries based on their openness status in the 1990s using the newly created data set of Wacziarg and Welch (2003, henceforth WW). WW extend the Sachs-Warner (1995) index of openness to the 1990s, and also expand the list of countries for which the index is available to include the economies of Central and Eastern Europe and the newly independent states of the former Soviet Union. Countries are classified as open if they satisfy all the following five criteria: (1) the average of unweighted tariffs in the 1990-1999 period is lower than 40%; (2) the average of core non-tariff barriers on capital goods and intermediates is lower than 40%; (3) the average black market premium over the period is lower than 20%; (4) the country does not have an export marketing board; and (5) the country is not socialist. Note that some of the openness criteria capture the extent to which the country is open with respect to trade of physical goods, while others, such as the black market premium, are more closely related to the degree of openness of financial markets. Altogether, the openness status is available for 141 countries. The variables and their sources are summarized in Table 1.

We thus end up with a sample of 134 countries for which data is available on GDP per capita, corruption, and openness. The list of countries, classified by their openness status and their degree of corruption is presented in Table 2. As can be seen, all closed countries, with the exception of Estonia, are characterized by at least a medium degree of corruption. On the other hand, open economies exhibit a wide range of corruption levels. Most OECD countries are open and are characterized by low corruption. Interestingly, corruption and the lack thereof do not seem to be confined to any particular geographic region. Countries with low levels of corruption can be found in Sub-Saharan Africa (Botswana), Central America (Costa Rica, Trinidad and Tobago), East Asia (Hong Kong, Malaysia, Singapore, Taiwan) and among the transition economies of Central and Eastern Europe (Slovenia, Hungary). At the same time, these regions also have worthy representatives among the list of highly corrupt countries. Summary statistics for all of our variables are presented in Table 3.

2.2 Methodology

We proceed to test whether the simple relationship that is documented in Figure 1 is robust to a variety of different specifications and estimation techniques. We have a continuous measure of corruption and a binary indicator of openness, that takes on the value of 1 for open countries, and zero for closed countries. We are interested in testing whether the coefficient on the corruption variable in closed economies is significantly different from zero, and whether there is a significant difference in the corruption-output relationship between closed and open countries. To do this, we pool all countries together, and estimate the following regression equation:

$$\begin{aligned}\ln GDP_i &= \beta_0+\beta_1 CORRUPTION_i+\beta_2 OPEN_i+\beta_3 CORRUPTION_i\times OPEN_i \quad (1)\\ &\quad \beta_4' Continent_i+\beta_5' Continent_i\times OPEN_i+\varepsilon_i,\end{aligned}$$

where GDP_i is GDP per capita in country $i, Continent_i$ is a vector of dummy variables indicating continents, and ε_i is an error term that captures measurement errors and unobserved determinants of output. This regression implies that for *closed* countries, the equation becomes

$$\ln GDP_i = \beta_0 + \beta_1 CORRUPTION_i + \beta_4' Continent_i + \varepsilon_i,$$

whereas for *open* countries the relationship is

$$\ln GDP_i = (\beta_0 + \beta_2) + (\beta_1 + \beta_3) CORRUPTION_i + (\beta_4 + \beta_5)' \, Continent_i + \varepsilon_i.$$

We hypothesize that β_1 should be indistinguishable from zero, while $(\beta_1 + \beta_3)$ should be negative and significant. We estimate the equation with and without the continent dummies. These are included to capture fundamental differences in levels of output and corruption across different geographic regions that may drive the overall relationship between the two variables. We elaborate further on this point in the next section.

Several points in our econometric specification deserve special comment. First, note that we focus our attention on levels of income per capita rather than growth rates. This follows the recent works of Hall and Jones (1999) and KKM. The standard justification that is provided for this approach stems from the observation that it is levels, rather than growth rates, that capture fundamental cross-country differences in consumption, and hence also in welfare levels. Also, the level of GDP per capita can be interpreted as the cumulation of growth rates over the long run. In addition, the theoretical literature on growth predicts that in the long run all countries should grow at the same rate, so that cross-country differences in growth are by their nature transitory (Mankiw, Romer, and Weil, 1992; Barro and Sala-i-Martin, 1992). This prediction is confirmed by the finding in Easterly et al. (1993), who find that growth rates are weakly correlated across decades.[9]

Second, one may wonder whether our parsimonious approach is correct, and whether we should not include other determinants of output on the right hand side of equation (1). We take the view that equation (1) is a true long run relationship, and therefore it makes little sense to control for variables (such as stocks of physical and human capital, the size of government, the rate of inflation, etc.) that are themselves the endogenous outcomes of the process of economic development (e.g., Hall and Jones, 1999; Laporta et al., 1999).

2.3 OLS Results

In Table 4 we present simple OLS estimates of equation (1). Recall that the coefficient on corruption alone, β_1, reflects the correlation between corruption and output in closed

[9] In fact, we also estimated a version of the model in which the dependent variable is the country's growth rate between 1980 and 2003, using Mauro's (1995) index of corruption and Sachs and Warner's openness index for the 1980s. We did not find any relationship between corruption and growth in either open or closed countries.

economies, while the sum of the coefficients on corruption and on the corruption-openness interaction, $\beta_1 + \beta_3$, tells us about the correlation in open economies. In each column of the table we report the F statistic which tests for the significance of this sum, and its corresponding p-value: high values of the F statistic indicate that we can reject the null hypothesis that corruption has no effect on output in open economies.

Column (1) of Table 4 presents the estimation results for the basic specification without continent dummies. Corruption is strongly negatively associated with output in both closed and open economies. Notice that, contrary to conventional wisdom, in this specification openness on its own is unrelated to output. However, when we add continent dummies in column (2), the results differ markedly. Adding the continent dummies increases significantly the explanatory power of the model, with the R^2 increasing from 0.69 to 0.83.[10] Importantly, in this scpecification the relationship between corruption and output in closed economies becomes much weaker: the coefficient on the corruption variable drops from -0.96 to -0.28, with a t-statistic of -1.22. By contrast, corruption and output continue to be strongly negatively correlated in open countries: the difference between open and closed economies is statistically significant (t-statistic of -2.22), the implied coefficient on corruption in open countries is -0.80, and we strongly reject the null of no relationship between corruption and output (F-statistic = 251). Notice that in this specification openness is strongly associated with income.

Why are the results so different between columns (1) and (2)? The answer lies in Figure 1b, which represents a textbook example of the importance of controls for omitted variables. In closed economies, ignoring geographic differences, there appears to be a negative relationship between corruption and output. However, this negative relationship hides fundamental differences across continents. European countries enjoy on average higher levels of output and are less corrupt, African countries are much poorer and significantly more corrupt, while Asian countries are somewhere in between. If continent dummies are excluded, the regression line goes through these three blocks of countries, generating the negative relationship observed in column (1). It is sufficient to take into account the differences in levels of GDP and corruption between the continents to make the relationship for closed countries all but vanish. That is not the case among open countries, where, even after controlling for continent dummies, we strongly reject the null hypothesis of no relationship.

To strengthen this point, we ask whether there are significant differences in the corruption-

[10] The F-statistic for the joint significance of the continent dummies and their interaction with the openness indicator is equal to 15.95 (p-value = 0.000). It also should be noted that the continent dummies interacted with the openness indicator are also jointly significant, with F-statistic equal to 10.31 (p-value = 0.000).

output relationship *within* continents: if the connection between corruption and output is independent of regional, cultural and other differences between continents (as implied by the results of column 1), then we would expect to find a significant corruption coefficient in both open and closed economies. In columns (3) to (5), we estimate equation (1) separately for Africa, Asia and Europe.[11] In both Asia and Africa (columns 3 and 4), there is virtually no relationship between corruption and output in closed economies, and a significant negative relationship in open economies. For Europe, on the other hand, output and corruption are negatively linked in both open and closed economies (column 5). From now on, all our specifications will include continent dummies.

It could be argued that the differences that we found between open and closed economies stem from the fact that closed economies are on average poorer and more corrupt than open economies. We cannot directly condition on the level of GDP per capita, since sample selection on the basis of the dependent variable biases the regression coefficients. In particular, it is not difficult to show that restricting the sample to poor countries would result in an upward bias in the corruption coefficient (i.e., we would biased towards finding no correlation even if in fact the correlation is negative). However, looking separately at Africa (column 4) already alleviates much of the concern, since the poorest third of the sample is made up mainly of African countries, and nearly all African countries belong to this group. A similar argument can be made for Asia. We further probe into this point by restricting attention to only non-OECD countries, (column 6), and to only highly corrupt countries (those with a corruption index greater than zero, column 7). In both cases we find that the results of column (2) are virtually unchanged: corruption is uncorrelated with output in closed economies; by contrast, even among non-OECD or highly corrupt economies that are open, the correlation between corruption and output is negative and highly significant.

Finally, it could be that the difference between open and closed economies stems from the fact that closed economies are poorer and hence corruption is measured less accurately. If that is the case, the argument goes, the difference is due to the different extent of attenuation bias between open and closed economies. Fortunately, we can test this claim: KKM provide, for each index of governance and for every country and year, the standard error of the index, which they interpret as a measure of precision or reliability. For each country, we average the standard errors of the corruption index in 1996, 1998 and 2000, and we take this average as our index of noisiness. We then rerun our basic regression of column (2) using only the

[11] There is only a single closed economy in both North and South America, making it impossible to estimate the equation.

countries in the top third of the distribution of the noisiness index. The results are reported in column (8). Again, we find no effect of corruption in closed countries, and a significant negative effect in open countries.[12] To the extent that the KKM measure of precision indeed reflects measurement error, we can conclude that the differences between open and closed countries reported in columns (2)-(7) are not due to differences in the extent of attenuation bias. A final explanation for our failure to detect a significant relationship between corruption and output in closed countries is the small sample size (37 countries). This explanation also misses the mark: in 100 bootstrap samples of 37 open countries (not reported), we always find a negative and highly significant relationship between corruption and output.

It is worth spending some words on the relationship between openness and output. In column (1), surprisingly, openness is unrelated to output at all levels of corruption. On the other hand, adding continent dummies we typically find that openness is positively correlated with output for countries that are not highly corrupt.[13] For example the coefficients in column (2) indicate that in an African country with a zero value of the corruption index, being open is associated with output per capita being higher by 55 log points (statistically different from zero at the 6 percent level). Openness is negatively associated with output only if the corruption index is above 1.05. Similar results are obtained for the other specifications and the remaining continents. In Europe, the threshold level of corruption at which openness becomes negatively correlated with output is the lowest among all continents, at -0.33. This implies that for most post-communist countries (which have high values of the corruption index) openness and output are negatively correlated.

In Table 5 we try several alternative specifications to assess the robustness of the results. In column (1) we use data on corruption and openness from the 1970s and 1980s, taken from Mauro (1995), and as our openness variable we take the 1975 to 1984 average of the Sachs-Warner dummies. The coefficient on corruption in closed economies is -0.27, with t-statistic of -1.60, whereas in open economies it is -0.56 and highly significant (F-statistic equal to 49.73). Thus, our main conjecture holds also in the 1980s.

In columns (2) to (4) we explore the effects of using the single-year measures of corruption collected by KKM, rather than the average between 1996 and 2000. The results are in line with our previous findings, especially when we use the 1998 or the 2000 measure of corruption. The 1996 corruption measure yields a marginally significant (at the 10 percent level) relationship between corruption and output in closed countries, but the coefficient is still roughly one half of that for open countries.

[12] We obtain the same results if we use countries in the top half of the distribution of the noisiness measure.

[13] The effect of openness on output is $\beta_2 + \beta_3 \times CORRUPTION + \beta_5 CONTINENT$.

In columns (5) to (8), we test whether our results are robust to the addition of a number of exogenous control variables (latitude, religion, and size), which are commonly used in the governance literature.[14] The inclusion of these variables has essentially no effect on the estimated relationship between corruption and output, and on the differences between open and closed economies. The only exception occurs when we include the religion variables: the relationship between corruption and output in closed economies is significant at the 10 percent level, but the size of the effect is still half of that found in open economies.

2.4 Endogeneity

We emphasize once more that in all the previous discussion, we have refrained from attributing any causal meaning to the regression coefficients. We believe that the contrast in the corruption-output relationship between open and closed countries is remarkable, regardless of the direction of causality between the two variables. Nevertheless, it is clear that for both policymakers and academics it is also important to assess whether corruption has any causal effect on output. The OLS estimates presented above cannot be given a causal interpretation because of simultaneity bias and attenuation bias due to possible measurement error in the corruption measure. To address this problem, we run instrumental variable (IV) regressions, using a number of instruments taken from the existing literature. Appendix B describes the instruments and discusses the assumptions needed to justify their use.

Table 6 presents IV estimates of equation (1). In column (1), the instrument set is made up of legal origin dummies (following Laporta et al., 1999); in column 2, the percentage in the population that speaks English and the percentage that speaks a major European language (from Hall and Jones, 1999); in columns 3 and 4, the degree of ethnic fractionalization and the degree of linguistic fractionalization (based on Mauro, 1995, and Alesina et al., 2003); finally, in column 5, the instrumental variable is European settler mortality (following Acemoglu, Johnson and Robinson, 2001); in addition, the interaction of these variables with the openness dummy is also included in the instrument set, since the endogenous variable, corruption, enters equation (1) both linearly and interacted with the openness variable. There is substantial variability in the coefficients on the corruption and the corruption-openness interaction, but this is probably due to the weak power of the instruments in the closed countries sample, which leads to highly imprecise estimates.[15] In fact, in contrast to

[14] Alesina and Spolaore (2003) argue that size is in fact determined endogenously.

[15] The first stage F statistic is large in the first two specifications, somewhat smaller in the third and fifth specifications, and in column (4) it barely exceeds conventional significance values and is substantially

the wide range of estimates in the individual coefficients, the implied effect of corruption on log GDP in open economies (i.e., the sum of the two coefficients) ranges from -0.797 to -1.842, a result in line with the OLS estimates of Table 4. In all five cases, the F test for the hypothesis that the sum of the coefficients is equal to zero is soundly rejected. By contrast, in four of the five specifications, we cannot reject the null hypothesis of no correlation between corruption and output in closed countries.

It can be argued that openness should also be treated as an endogenous variable. Countries that adopt more free-market trade policies may also adopt free-market domestic policies and stable fiscal and monetary policies, which could potentially increase their output per capita. To address this issue, we use as instrument for openness Frankel and Romer's (1999) log of the predicted trade share (imports plus exports as a fraction of GDP) obtained from a gravity model of bilateral trade.[16] To avoid a cumbersome specification with a very large number of instruments (every interactionm of openness with the continent dummies would have had to be instrumented), we estimated the model separately for Africa, Asia/Oceania, and Europe.[17] The instrument set is composed by the legal origin dummies (which had the strongest first stage F-statistic in Table 6), the Frankel-Romer instrument, and all possible interactions between the two. The results are presented in Table 7. In Asia/Oceania and Europe the results are in line with all our previous findings, while in Africa corruption is uncorrelated with output in both open and closed countries. However, the first stage F statistics are fairly small, casting some doubts on the reliability of these estimates. Using the other instruments for corruption revealed the same pattern of results.

Altogether, the IV results confirm the findings of Tables 4 and 5, even though the interpretation now is causal. In open economies, corruption is strongly negatively correlated to output, whereas, in closed economies, in most specifications we find no such relationship.

3 Interpreting the Results

Why is it then that the negative relationship between corruption and output per capita is restricted to open countries alone? To shed further light on this issue, we now delve deeper into the interactions between corruption, openness, and output. In particular, we first

smaller than the "rule of thumb" value of 10, which casts some doubt on the validity of the estimates. In the first two columns, where the equation is overidentified, the Hansen test does not reject the null of the validity of the instruments.

[16] See Appendix 2 fo details on the instrument.

[17] In North and South America there are not enough closed countries to carry out this analysis.

decompose income to gauge whether our pattern of results is attributable to physical capital, to human capital, or to total factor productivity. We then investigate which particular aspects of openness appears to affect the relationship between corruption and output.

3.1 The Components of Output

The common view among economists is that corruption affects output by distorting the allocation of resources. This view contrasts with the hypothesis, which is prevalent among economic historians and political scientists, that in an economy that has a rigid bureaucracy, corruption may be beneficial as a way of 'oiling the wheels of bureaucracy.' The decomposition of output into its components, capital (physical and human) and total factor productivity (TFP) offers a glimpse into this controversy. We follow Hall and Jones (1999) in taking the view that TFP mainly reflects market efficiency.

We assume that each country has a Cobb-Douglas production function with physical and human capital as its inputs, and Hicks-neutral technological progress:

$$Y_i = A_i K_i^{\alpha} \left[e^{\psi(E_i)} L_i \right]^{1-\alpha},$$

where K and L are capital and labor, E is average years of schooling, the function $\psi(\cdot)$ describes the effects of schooling on labor productivity, and A is the productivity term. Dividing both sides of the equation by L and taking logs yields the standard textbook decomposition of output per worker into a part due to the capital-labor ratio, a part due to human capital, and a part due to total factor productivity:

$$\ln(Y_i/L_i) = \alpha \ln(K_i/L_i) + (1-\alpha)\psi(E_i) + \ln A_i. \tag{2}$$

We set $\alpha = 1/3$, and follow Hall and Jones by letting $\psi(\cdot)$ be a piecewise linear function with coefficients derived from microeconomic evidence.[18] To measure E, we use average years of schooling of the population aged 25 and over in 1995, taken from the Barro-Lee (2000) data set. Since this variable is available in only 104 countries (and is not available in all the newly created countries of Central Europe and the former Soviet Union), we impute the missing schooling data using data on literacy rates and enrollment in school taken from the World

[18] Hall and Jones (1999) base their estimates on a rich survey by Psacharopoulos (1994) on returns to schooling estimates across the world. As in Hall and Jones, we assume that the rate of return for the first four years of education is 13.4 percent. For the next four years, we assume a value of 10.1 percent. Finally, for education beyond the eighth year, we assume a value of 6.8 percent, which is the average rate of return in OECD countries as reported by Psacharopoulos.

Bank (2001). Finally, we calculate each country's capital stock in 2000 using a perpetual inventory method and data on investments dating back to as early as 1960 from the Penn World Tables, mark 6.1 (Heston, Summers and Aten 2002).[19] These components allow us to obtain $\ln A$ as the residual in equation (2).

In Table 8 we present regressions similar to those of Table 4, where the dependent variables are the three separate components of output per worker. Data on the individual components of output, on corruption and on openness are available for 126 countries. In the first three columns we report results for the whole sample. A striking result is that corruption is unrelated to physical capital in closed countries (in fact the coefficient is positive), while the correlation is strong and negative in open countries, mirroring the findings of Table 4. The same pattern appears when human capital is the dependent variable, although the magnitude of the coefficients is diminished. In contrast to these results, corruption is negatively related to total factor productivity, regardless of whether the economy is open or closed. The same pattern of results emerges when restricting attention to the subset of highly corrupt countries (columns 4 through 6).

Altogether, the results in Table 8 suggest that reduced capital accumulation is the main channel that can explain the difference in the corruption-output relationship between open and closed economies. Although our findings are not inconsistent with the view that corruption does harm the economy through the distortion of resource allocation, they do point to an additional, important, channel through which corruption adversely affects the economy.

[19] We take countries with investment data going back at least to 1980. The initial value of the capital stock is imputed to be equal to the value of investment in the first available year, divided by $(g+\delta)$, where g is calculated as the average geometric growth rate of investment in the first ten years, and δ is the depreciation rate, which we assume to be equal to 6 percent.

For the Czech and Slovak republics, the capital stock was calculated as follows. We took Czechoslovakia's capital stock in the last available year (1990, in the Penn World Tables, mark 5.6), and assigned to the Czech and Slovak republics the capital stock so that the ratio of the initial capital stock is the same as the ratio of total GDP. So, for example, the Czech Republic's capital stock in 1990 was calculated as

$$K_{Czech\ Republic,1990} = \frac{GDP_{Czech\ Republic,1990}}{GDP_{Czechoslovakia,1990}} \times K_{Czechoslovakia,1990}$$

For the former republics of the Soviet Union, the capital stock was calculated as follows. We calculated the capital stock in Russia in 1991 following the same procedure used for Czech and Slovak republics, using the USSR's capital stock and GDP in 1989 as the base. With this value in hand, we imputed the capital stock for Russia up to the year 2000 using the perpetual inventory method. For the remaining countries of the former Soviet Union, we calculated the capital stock in the first available year of data assuming that the capital to GDP ratio in that year equalled that of Russia in the same year, and updated that series using the perpetual inventory method.

3.2 What Type of Openness Matters?

A plausible explanation to our findings may be that corruption somehow distorts trade relationships. If that is the case then the larger the share of trade in output, the greater is the damage that corruption causes, and closed countries who trade the least are less susceptible to its effects.

We test this hypothesis in columns (1) through (4) of Table 9. We replicate the regression in column (2) of Table 4, using different measures of openness. In column (1) we classify countries as open if their share of imports plus exports over GDP in 1995 (taken from Dollar and Kraay, 2003) is above the median, and closed otherwise, while in column (2) we use this share as a continuous measure of openness. In column (3) openness is a binary variable taking the value of 1 if the level of tariffs is below 20 percent, and in column (4) openness is equal to one minus the average tariff.[20] Interestingly, in all four specifications we find a strong negative relationship between corruption and output in both closed and open economies. If anything, the negative relationship is stronger if the economy is closed.

Next, we explore whether the difference in the effect of corruption on output between open and closed economies is due to a country's degree of financial openness using the black market premium as our measure of financial openness. The black market premium is in practice the effective tax that must be paid in order to circumvent restrictions on the movement of capital, and can be viewed as a measure of the ease with which one can move money in and out of the economy. Therefore, countries with a high black market premium can be considered, for all practical purposes, to be financially closed. Data on the black market premium is taken from Wacziarg and Welch (2003) and is available for 137 countries: it represents the average black market premium over the 1990-1999 period. In column (5) of Table 9 we classify countries dichotomously as open or closed based on whether the black market premium is below or above 20 percent. The results are quite similar to those found using the overall openness measure: in financially closed countries we find no significant relationship, and in financially open countries we find a strong negative relationship between corruption and output. In column (6) we use 1 minus the black market premium as our measure of financial openness: this variable runs from zero (countries with a black market premium above 100 percent) to one (countries where the black market premium is equal to zero). The results resemble quite closely those in column (5): the coefficient on corruption, representing the effect of corruption on output in a completely closed economy, is statistically indistinguishable from

[20] We use the average level of unweighted tariffs between 1990 and 1999, taken from Wacziarg and Welch (2003).

zero. The interaction term is negative and imprecisely estimated. However, the sum of the coefficients, which represents the effect of corruption on output in an economy with a black market premium of zero is highly significant. In other words, the higher the degree of financial openness, the stronger the negative correlation between corruption and output. The evidence in Table 9 suggests that the contrast in the corruption-output relationship is mostly a contrast between countries that are *financially* open or closed, rather than open or closed in terms of the volume of trade.

Finally, we should mention that we make no attempt to use direct measures of capital flight and to study their relationship with corruption and openness.[21] The reason for this is that in an open economy, illegally obtained funds can be legally transferred abroad. Officials who amass funds through corruption, can export them legally, without such tranfers being recorded as capital flight. Hence, the relationship between corruption and capital flight is less pronounced in open than in closed economies. For that reason we prefer in our context to use the term "capital drain" which encompasses both legal and illegal transfers of capital.

4 Capital Drain

In this section we present a model for the relationship between corruption, openness, and output that is consistent with the three basic stylized facts that we have described above: (1) corruption is negatively correlated with output in open economies, but not in closed economies; (2) the difference between closed and open economies is mainly due to the different effect of corruption on capital accumulation in closed and open economies, respectively; and (3) the extent to which corruption affects output is determined primarily by the degree of financial openness.

The explanation we provide for these three observations is simple. Corrupt officials wish to hide the proceeds of their illegal activities as far as possible from the reach of law enforcement authorities in their own country. Therefore, to the extent they can do this, corrupt officials prefer to smuggle the money they steal outside of the country. The advantage of doing so is that if they are caught, then the authorities would not be able to retrieve the stolen money. Smuggling illegally obtained capital outside the country has the additional advantage of making consumption less conspicuous, which reduces the likelihood of getting caught. On the other hand, conventional wisdom suggests that investors strongly prefer to invest in their home country, where they have better information on investment

[21] See Boyce and Ndikumana (2001) for a recent estimate of capital flight in Sub-Saharan Africa.

opportunities (French and Poterba, 1991). The extent to which illegal money will be diverted abroad depends on the cost of transferring it. In an open economy, the cost of smuggling capital outside the economy is low, and the net return on overseas investment is high. Thus, ceteris paribus, in an open economy, more resources would be diverted abroad, depleting the economy's stock of capital, and reducing output. In contrast, in a financially closed economy, it is more expensive to divert capital abroad, and so the damage to the economy may be significantly smaller. This explanation suggests that capital drain can potentially be an important channel through which corruption affects output.[22]

4.1 Model

Our model extends the standard Solow model to include corruption and capital drain. Consider a dynamic one-sector economy with the production function

$$Y_t = A_t K_t^{\alpha} \left[e^{\psi(E_t)} L_t \right]^{1-\alpha} \qquad 0 < \alpha < 1 \tag{3}$$

where $t \geq 1$ indicates period. The government taxes output and uses the proceeds to produce the common factor of productivity, A_t. However, corrupt bureaucrats steal part of the tax revenues which implies that less can be used to pay for the production of A_t. Letting τ_t denote the tax rate, c_t the total amount of resources stolen by bureaucrats, s the saving rate and $1 - \phi$ the proportion of stolen resources that are diverted abroad, A_{t+1} and K_{t+1} are given by the following equations

$$A_{t+1} = (\tau_t Y_t - c_t)^{\beta} \qquad \beta > 0 \tag{4}$$

$$K_{t+1} = (1 - \tau_t) s Y_t + s\phi c_t \qquad 0 \leq \phi \leq 1. \tag{5}$$

Namely, in every period the government uses the collected taxes less the amount stolen, $\tau_t Y_t - c_t$, to produce the next period's common factor of productivity, A_{t+1}; and the next period's amount of productive capital, K_{t+1}, is equal to the amount of after-tax savings, $(1 - \tau_t) s Y_t$, plus the amount of stolen resources that are reinvested in the economy, $s\phi c_t$. We assume that the rest of the stolen resources are either smuggled outside of the economy, or consumed with the same proportion, s, in which legal output is consumed.

To ensure that total return to capital in both the private and public sectors is decreasing, we require that the two parameters α and β be such that

$$\alpha + \beta < 1.$$

[22] Indeed, Pastor (1990) finds that exchange controls reduce the extent of capital flight.

Every period, a measure one of bureaucrats or state officials each choose an amount c_t of resources to steal that would maximize their expected utilities:

$$(1 - \pi(c_t))\, u(w_t + c_t) \tag{6}$$

subject to the constraint

$$c_t \leq \tau_t Y_t. \tag{7}$$

The function $u(\cdot)$ denotes the state officials' utility function; $\pi(c_t)$ denotes the probability of getting caught as a function of the amount of resources stolen, c_t; and w_t denotes the state officials' wage. The utility function $u(\cdot)$ is assumed to be non negative, increasing, and concave. State officials' utility when they are caught is normalized to zero. The probability of getting caught $\pi(\cdot)$ is assumed to be increasing, differentiable, and convex on the interval $[0, \overline{c}]$ for some $\overline{c} < \infty$, to be equal to one for all $c \geq \overline{c}$, to be equal to zero at zero, and to have a derivative of zero at zero. We assume that officials can only steal from the taxes they themselves have collected, which implies that $c_t \leq \tau_t Y_t$. Because all state officials are identical, they each steal the same amount c_t. The fact that there is a measure one of state officials implies that c_t is also the total amount of resources stolen in the economy, and that each state official is responsible for the collection of $\tau_t Y_t$ of tax revenues at t.

For simplicity, we assume that the officials' wage rate in every period is proportional to income, that is, $w_t = \gamma Y_t$ for some fixed $\gamma > 0$. We refer to the amount stolen in period t, c_t, as the level of corruption in the economy in period t.

In every period the government, who anticipates the amount stolen by its officials, sets the tax rate τ_t to maximize the discounted value of future output.

Finally, for simplicity, we assume that $e^{\psi(E_t)} L_t = 1$ for all $t \geq 1$.

4.2 Equilibrium

Definition. A sequence $\{(Y_t, A_t, \tau_t, c_t)\}_{t \geq 1}$ is a competitive equilibrium of the economy if it satisfies equations (3)-(5), and is such that for every $t \geq 1$, c_t is chosen optimally by state officials given Y_t and τ_t, and τ_t is chosen optimally by the government given Y_t and c_t.

Fix some period t. For every level of Y_t and τ_t, denote the state officials' optimal choice of corruption by $c(Y_t, \tau_t)$. As shown by Lemma 1 below, the amount of resources stolen in every period, decreases as the economy becomes richer.[23]

[23] This is consistent with the empirical findings of Van Rijckeghem and Weder (2001) who show that corruption is decreasing in the wage paid to state employees (which, in our model, is assumed to be increasing in Y_t).

Lemma 1. *There exists a level of resources* $\underline{Y} > 0$ *such that in every period* $t \geq 1$, *for every* $Y_t \leq \underline{Y}$, *the state officials' optimal choice of corruption is given by* $c(Y_t, \tau_t) = \tau_t Y_t$ *for every* $\tau_t \in [0,1]$. *For* $Y_t > \underline{Y}$, $c(Y_t, \tau_t)$ *declines continuously in* Y_t *and is independent of the tax rate* τ_t *except in case where the tax rate is so low that state officials would want to set* $c_t > \tau_t Y_t$ *if they could. In this case, because* c_t *is constrained to be smaller than or equal to* $\tau_t Y_t$, $c(Y_t, \tau_t) = \tau_t Y_t$.

The reason that corruption declines with output is simple. Higher wages reduce the marginal utility from corruption, and therefore, weaken the incentive of government bureaucrats to steal. Hence, our assumption that state officials' wages are proportional to output implies that bureaucratic corruption is lower in richer countries. In very poor economies, that is when $Y \leq \underline{Y}$, the marginal utility from corruption is so high and tax revenues are so low that all tax revenues are stolen.

As mentioned above, in every period, the government, who anticipates the level of corruption, determines the tax rate τ_t so as to maximize the discounted present value of output.

Lemma 2. *In equilibrium, if* $Y_t > \underline{Y}$ *and the government expects the level of corruption to be equal to* $c_t = c(Y_t, \tau_t)$, *then it sets the tax rate equal to*

$$\tau(Y_t, c_t) = \frac{\beta}{\alpha + \beta} + \frac{(1+\phi)\alpha}{\alpha + \beta} \cdot \frac{c_t}{Y_t}; \tag{8}$$

if $Y_t \leq \underline{Y}$, *then the government is indifferent among all tax rates* $\tau_t \in [0,1]$.

Lemma 2 implies that greater corruption leads to higher tax rates. This is because the government anticipates the loss of revenues caused by corruption and reacts to it by raising the tax rate. However, if the economy is so poor that all the tax revenues will anyway be stolen, then the tax rate becomes immaterial.

Three remarks are in order. First, if $Y_t > \underline{Y}$, then the government sets the tax rate τ_t in such a way that $c_t < \tau_t Y_t$.

Second, by construction, taxes in our model are not distortionary. If they were, as they usually are in practice, then corruption would have caused an additional harm by inducing higher tax rates.

Third, whenever, $Y_t > \underline{Y}$, corruption affects output only through its effect on the level of capital drain. In the extreme case in which the economy is completely closed and $\phi = 1$, the level of corruption has no effect on equilibrium at all. To see this, suppose that if there was no corruption ($c = 0$), then by Lemma 2 the government would have set the tax rate optimally at $\tau^* = \frac{\beta}{\alpha+\beta}$, with the resulting levels of $A^* = (\tau^* Y)^\beta$ and $K^* = (1-\tau^*)Y$. If $\phi = 1$, then given any corruption level c, setting $\tau = \tau^* + c/Y$ generates the same values of A^* and K^*, as in the economy without corruption.

In equilibrium, the state of the economy at date t is completely determined by the value of Y_t. In order to study the dynamics of the economy, it is convenient to express Y_{t+1} in terms of Y_t. Equations (3)-(5), imply that $Y_{t+1} = f_\phi(Y_t)$ where $f_\phi(\cdot)$ is given by:

$$f_\phi(Y_t) = (\tau_t Y_t - c_t)^\beta ((1-\tau_t) s Y_t + \phi s c_t)^\alpha \tag{9}$$

where $c_t = c(Y_t, \tau_t)$ and τ_t is given by (8). The following lemma describes the properties of $f_\phi(Y_t)$.

Lemma 3. *The function $f_\phi(\cdot)$ has the following properties:*

1. *$f_\phi(\cdot)$ is continuous;*
2. *For $Y \in [0, \underline{Y}]$, $f_\phi(Y) = 0$; $f_\phi(\cdot)$ is strictly increasing on $[\underline{Y}, \infty)$;*
3. *$f_\phi(Y)$ tends to infinity with Y;*
4. *The derivative of $f_\phi(Y)$ tends to zero as Y tends to infinity.*

The properties of $f_\phi(\cdot)$ imply that, generically, there are two possibilities. Either the entire graph of f_ϕ lies below the 45^0 line, in which case there is a unique steady-state equilibrium at $Y = 0$; or f_ϕ crosses the 45^0 line at least twice in which case there are at least two stable steady-states, one at zero and the other at some $Y^* > 0$ as illustrated in Figure 2.

In this case, the equilibrium to which the economy converges depends on the initial level of output. If $Y > \hat{Y}$, then the economy converges to a steady state with high output and low corruption, and if $Y < \hat{Y}$, then the economy converges to a steady state with zero output and high corruption.

Note that $f_\phi(\cdot)$ increases and $\underline{Y}$ declines as the probability of getting caught, π, increases. In the extreme case where $\pi(0) = 1$, there is no corruption and the model becomes very similar to a standard growth model. Note also that $f_\phi(\cdot)$ is increasing and therefore $\underline{Y}$ declines in ϕ. This is due to the fact that capital drain declines with ϕ (again, for simplicity, we focus our attention only on the negative effects of openness in facilitating capital drain while ignoring its benefits). Consequently, in a more open economy, the threshold level of wealth above which there is convergence to the good steady state is higher, which implies that it is more likely that the economy would be trapped in a vicious cycle with high corruption and low wealth.

5 Conclusions

Many agree that corruption and poverty feed on each other to create a vicious cycle: high corruption leads to poverty, which generates yet more corruption, and so on. Bardhan (1997) for example states "it is probably correct to say that the process of economic growth ultimately generates enough forces to reduce corruption" (p. 1329). But, as Williams (2000) cautions, because "the 'take off' phase of economic growth seen as necessary for [...] development had not materialized. [...] It is no longer legitimate to assume that development would resolve the multiple problems besetting the South" (p. ix). This pessimistic observation is at odds with the fact that many of today's developed economies experienced widespread corruption during their history, and yet have managed to break out of the vicious circle to become rich and non corrupt. Theobald (1990), for example, describes the widespread corruption of state legislatures and city governments during the "gilded age" of 1860s and 1870s in the U.S. (see also Josephson, 1934, and Callow, 1966). In England, corruption was so severe at times that Wraith and Simkins (1963) write "The settlements of 1660 and 1688 inaugurated the Age of Reason, and substituted a system of patronage, bribery, and corruption for the previous method of bloodletting" (p. 60). Indeed, Bardhan (1997, p. 1328) notes that "historians [...] point to many cases when a great deal of corruption in dispensing licenses, or loans, or mine and land concessions has been associated with (and may have even helped in) the emergence of an entrepreneurial class."

What is it that makes present corruption so much more harmful to development than past corruption? Why is corruption said to stall development in many of today's developing economies, but not in the developing economies of one or more centuries ago?

Our answer to this puzzle is that one or two centuries ago, illegally obtained capital remained and was invested in one's home country: a late 19th century public official implicated with corruption in New York could safely enjoy the proceeds of his graft in Minneapolis or in San Francisco. Thus, there was no need to smuggle illegally obtained resources outside the economy and the gains from corruption became part of the economy's productive capital. In contrast, today it is harder for public officials, even in third world countries, to hide the proceeds of their illegal activities within their own country, and therefore, a larger proportion of stolen money is smuggled abroad.

This insight may also help explain the otherwise puzzling flow of capital from poor to rich countries (Lucas, 1990), which conflicts with the predictions of conventional neoclassical growth theories according to which capital should flow from rich economies where the return to capital is relatively low to poor economies where the return to capital is relatively high.

Appendix A

Proof of Lemma 1. Inspection of the necessary and sufficient first-order condition of state officials' optimization problem reveals that $c(Y_t, \tau_t)$ is implicitly given by the unique solution, c_t, of the following equation,

$$(1 - \pi(c_t))\, u'(\gamma Y_t + c_t) = u(\gamma Y_t + c_t)\pi'(c_t)\,, \tag{10}$$

provided it exists, or by $\tau_t Y_t$, whichever is smaller. The properties of $u(\cdot)$ and $\pi(\cdot)$ imply that $c(Y_t, \tau_t)$ is continuous and nonincreasing in Y_t, and nondecreasing in τ_t. The value $\underline{Y}$ is given by the solution to the equation $c_t(Y, 1) = Y$. As Y_t tends to infinity, $c(Y_t, \tau_t)$ tends to zero; and $c(Y_t, \tau_t) = \tau_t Y_t$ for all sufficiently small values of Y_t and τ_t. By (10), $c(Y_t, \tau_t)$ is independent of τ_t except in case where τ_t is so small that state officials would want to set $c_t > \tau_t Y_t$ if they could. In this case, because c_t is constrained to be smaller than or equal to $\tau_t Y_t$, $c(Y_t, \tau_t) = \tau_t Y_t$. ■

Proof of Lemma 2. The size of the tax rate τ_t has a direct effect on future output only through its effect on Y_{t+1}. As will become clear below when we specify the dynamics of the model, Y_{t+2} is positively related to Y_{t+1}. Similarly, Y_{t+3}, in turn, is positively related to Y_{t+2} and so on. Therefore, choosing the tax rate τ_t to maximize Y_t would also maximize the discounted present value of output, regardless of which discount rate is chosen.

The government's objective in every period t may thus be limited to choosing the tax rate $\tau_t \leq 1$ that maximizes the level of output Y_t in period t, which, by (3)-(5) is given by

$$Y_{t+1} = (\tau_t Y_t - c(Y_t, \tau_t))^{\beta} \left((1 - \tau_t) s Y_t + s\phi c(Y_t, \tau_t)\right)^{\alpha}. \tag{11}$$

Obviously, if it is at all possible, or whenever Y_t is sufficiently large, the government would set $\tau_t > \frac{c_t}{Y_t}$. In this case, $\frac{\partial c(Y_t, \tau_t)}{\partial \tau_t} = 0$, and so differentiation of (11) with respect to τ_t and equating the derivative with zero yields (8). The second order condition for optimization is satisfied in this solution. When Y_t is not sufficiently large, $c(Y_t, \tau_t) = \tau_t Y_t$ for every $\tau_t \leq 1$ and so every $\tau_t \in [0, 1]$ is optimal. ■

$$f_{\phi}(Y_t) = (\tau_t Y_t - c_t)^{\beta} \left((1 - \tau_t) s Y_t + \phi s c_t\right)^{\alpha} \tag{12}$$

Proof of Lemma 3. (1) Continuity is a consequence of the continuity of $c(Y_t, \tau_t)$ and $\tau(Y_t, c_t)$.

(2) By Lemma 1, for $Y \leq \underline{Y}$, $c(Y, \tau) = \tau Y$ for every tax rate $\tau \leq 1$, from which it follows that $f_\phi(Y) = 0$. To see that f_ϕ is increasing for $Y > \underline{Y}$, note that if c declines from c_1 to c_2, then the government can increase output from Y_1 to Y_2 by choosing $\tau_2 = \tau_1 + \frac{c_1 - c_2}{Y}$,

$$\begin{aligned} Y_2 &= (\tau_2 Y_t - c_2)^\beta ((1 - \tau_2) s Y_t + \phi s c_2)^\alpha \\ &= (\tau_1 Y_t - c_1)^\beta ((1 - \tau_1) s Y_t + \phi s c_1 + (1 - \phi)(c_1 - c_2))^\alpha \\ &> Y_1. \end{aligned}$$

For $Y > \underline{Y}$, by Lemma 1, c declines with Y and is unaffected by τ. Hence, an increase by Y reduces c in which case there exist τ for which output increases.

(3) Follows from the fact that $c(Y, \tau)$ is nonincreasing in Y and independent of the value of τ when Y is large, and the fact that $\tau(Y_t, c(Y_t))$ is decreasing in Y_t. Finally,

(4) $f_0(Y_t)$ is bounded from above by $sY_t^\beta (Y_t + \phi c_t)^\alpha$ which has a derivative that tends to zero as Y_t tends to infinity. ■

Appendix B

If corruption and output are jointly determined, then one cannot provide a causal interpretation to the OLS estimates of equation (1). Moreover, since corruption is only imperfectly measured, the OLS estimates suffer from attenuation bias as well as simultaneity bias. Both biases can be addressed if we have exogenous instruments that are correlated with corruption but uncorrelated with the error term in equation (1). In Table 6, we address these problems using several different sets of instruments that have been used previously in the literature.

La Porta, et al. (1999) show that the quality of government is strongly related to a country's legal origins. Countries with a French or socialist legal system tend to have lower quality of government, relative to countries with a legal system based on English common law: hence, these countries tend to have more corruption, less protection of property rights, a higher regulatory burden, and less efficient provision of essential public goods. La Porta et al. argue that English common law, which developed as a reaction of Parliament and property owners to attempts by the sovereign to expropriate them, is more conducive to good governance; on the other hand, French civil law, which developed as an instrument of state building and the expansion of the sovereign's power, tends by its nature to restrict individuals' property rights; socialist law is an extreme case of the state creating institutions that protect the Communist party's hold on power, without much respect for individual's rights and freedoms. In using the legal origin dummies as instruments, we assume that the only effect of legal origins on present output is through their effect on the quality of government.

Mauro (1995) and Alesina, Devleeschauwer, Easterly, Kurlat and Wacziarg (2003) argue that societies that are more ethnically or linguistically fractionalized have more corrupt governments, as bureaucrats may have larger incentives to steal money to favor members of their own group. Since the degree of ethnic and linguistic fractionalization is to a large extent determined by the arbitrary straight-line borders traced by colonial powers in the past, it seems reasonable to assume that this variable is uncorrelated with the disturbance in today's output equation.

Hall and Jones (1999) and KKM instrument social infrastructure using the fraction of the population who speaks English and other major European languages as a mother tongue. The underlying idea for these instruments is that countries where the extent of Western European influence was greater were more likely to adopt a social and economic infrastructure that was favorable for economic development: protection of property rights, a system of checks and balances in government, and the free-market ideas of Adam Smith. Moreover, factors that attracted Western European colonizers five centuries ago (an abundance of natural resources, sparse population) seem unlikely to be correlated with unobserved determinants of productivity today.

Acemoglu, Johnson and Robinson (2001) suggest using European settler mortality as an instrument for current institutions. Their argument is based on the assumption that high settler mortality in the colonies deterred European settlements and therefore prevented the establishment of European institutions in those territories. That in turn influences current institutions, and thereby current economic performance.

In Table 7, we use as instrument for openness Frankel and Romer's (1999) log of the predicted trade share (imports plus exports as a fraction of GDP) obtained from a gravity model of bilateral trade. The gravity model isolates the component of trade that is due to purely geographic variables, such as distance to other trading partners, size, and whether the country is landlocked. Our variable is taken from Dollar and Kraay (2003), who use data from the 1990s to update Frankel and Romer's original instrument. The straightforward approach would have been to instrument for openness every time it appears in the regression equation. This would have resulted in a cumbersome specification with a very large number of instruments (every interaction of openness with the continent dummies would have had to be instrumented) . To avoid this, we estimated the model separately for Africa, Asia/Oceania, and Europe.

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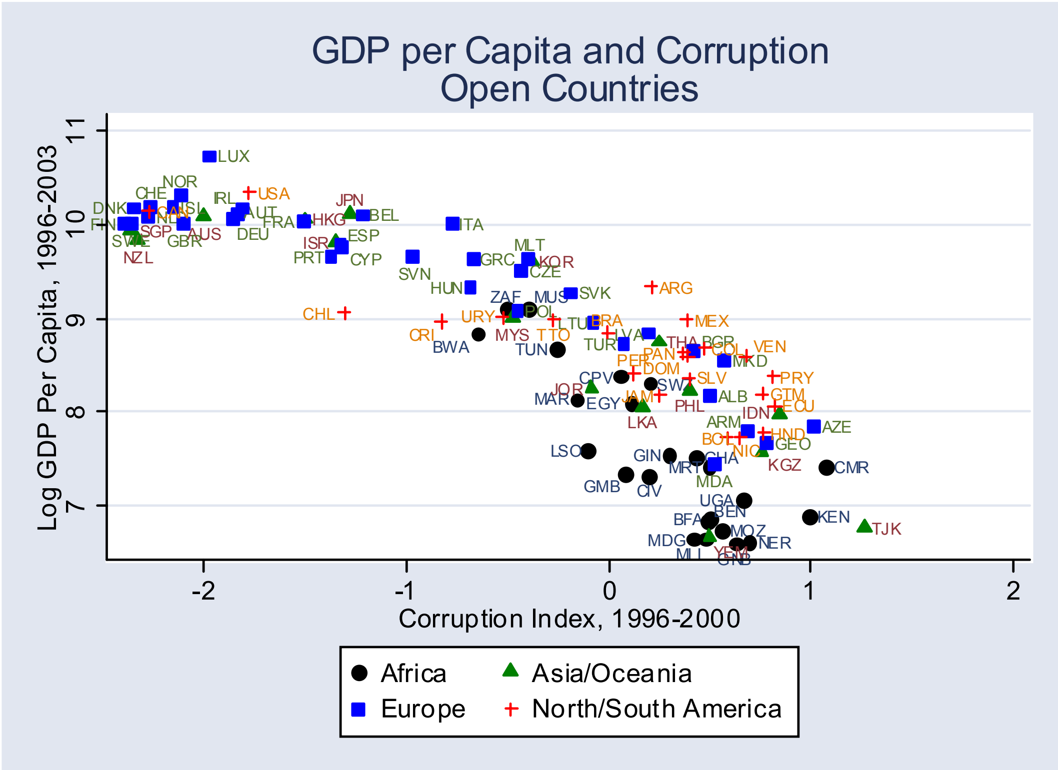

Figure 1a: Corruption and Economic Development – Open Countries

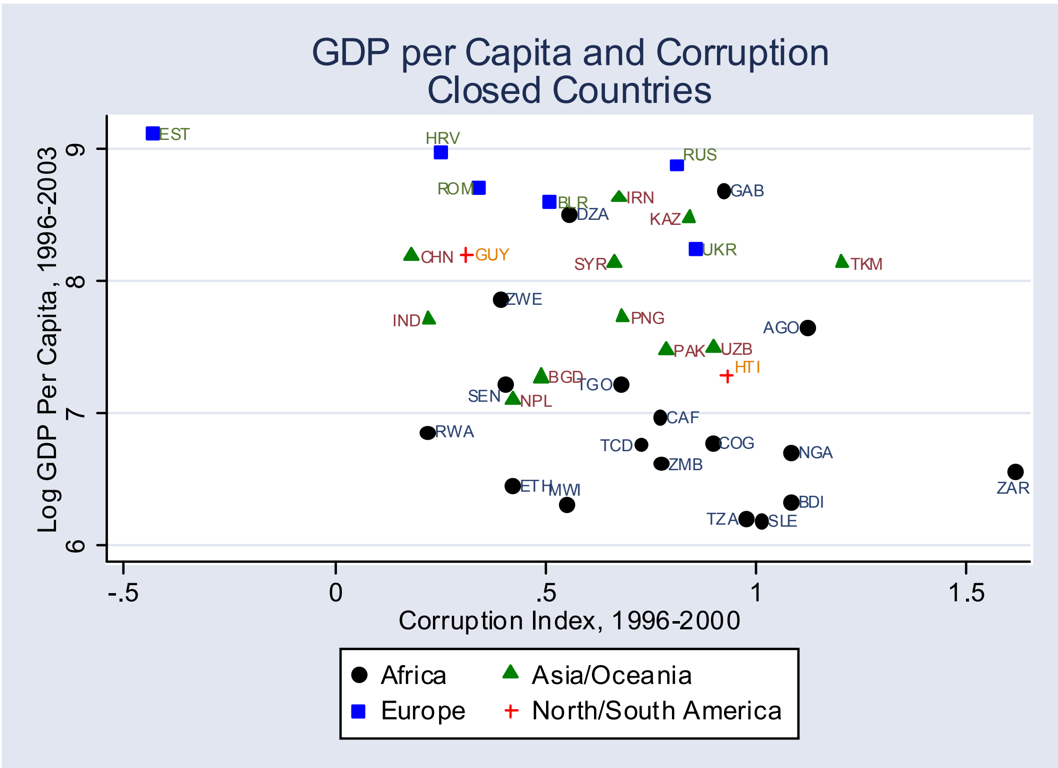

Figure 1b: Corruption and Economic Development – Closed Countries

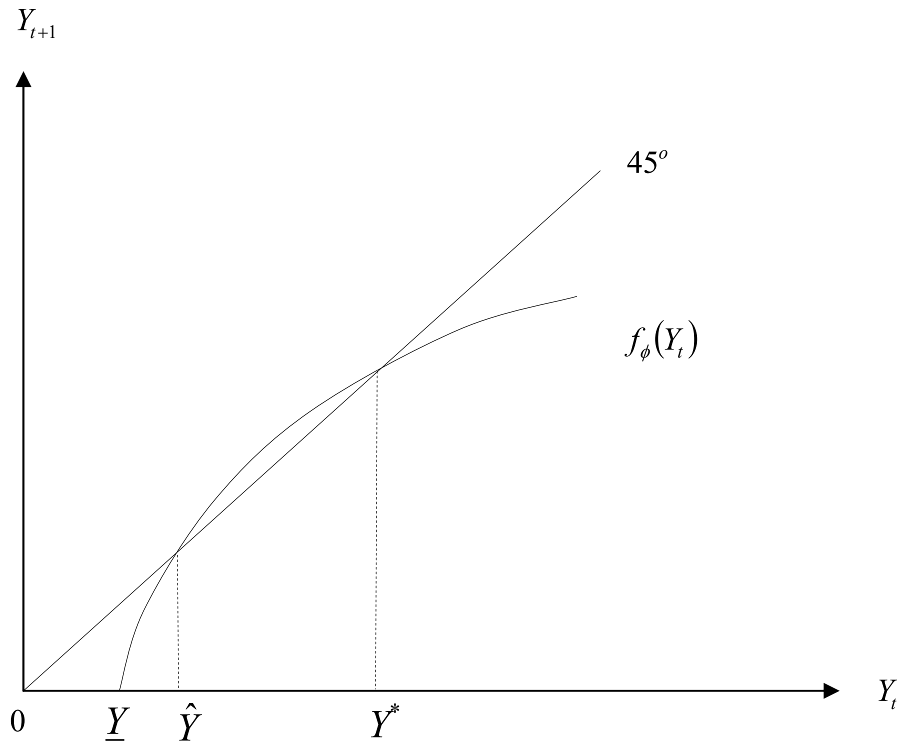

Figure 2: Y_{t+1} as a Function of Y_t

Table 1: Variable Description and Sources

Variable	Description	Source	Availability
Log GDP per capita, 1996-2003	GDP per capita in current US $, at purchasing power parity	World Development Indicators Online, World Bank (2004)	173 countries
Corruption, 1996-2000	An aggregate of several indicators, collected by international organizations, political and business risk rating agencies, think tanks and non-governmental organizations, measuring "the exercise of public power for private gain." The index is standardized to have mean 0 and standard deviation 1.	Kaufmann, Kraay and Mastruzzi (2003).	185 countries
Corruption, 1982	An index for "the degree to which business transactions involve corruption or questionable payments," collected by Business International, a private firm, during the period 1980-1983. The raw index is standardized to have mean 0 and standard deviation 1.	Mauro (1995)	68 countries
Wacziarg-Welch openness dummy, 1990-1999	A country is defined as open if all the following criteria are met: 1) the average of unweighted tariffs in the 1990-1999 period is lower than 40%; 2) the average of core non-tariff barriers on capital goods and intermediates is lower than 40%; 3) the average black market premium over the period is lower than 20%; 4) the country does not have an export marketing board; 5) the country is not socialist.	Wacziarg and Welch (2003)	141 countries

Table 1: Variable Description and Sources (continued)

Variable	Description	Source	Availability
Sachs-Warner openness dummies 1975-1984	A country is defined as open in any given year if it meets all the following criteria: 1) the average of unweighted tariffs is lower than 40%; 2) the average of core non-tariff barriers on capital goods and intermediates is lower than 40%; 3) the black market premium is lower than 20%; 4) it does not have an export marketing board; 5) it is not socialist.	Sachs and Warner (1995)	110 countries
Legal origins	Dummies for whether the origin of the country's legal system is British (common law), French (civil law), German/Scandinavian (civil law) or socialist.	La Porta, Lopez-de-Silanes, Shleifer and Vishny (1999)	207 countries
Percentage English speakers	Percentage of the population who speaks English as their "mother tongue".	Alesina et al. (2002)	217 countries
Percentage European language speakers	Percentage of the population who speaks a major European language (English, French, German, Spanish, Portuguese) as their "mother tongue".	Alesina et al. (2002)	217 countries
Ethnic fractionalization	A variable measuring the probability that two randomly selected individuals in the population belong to different ethnic groups. Calculated as one minus the Herfindahl index of ethnic group shares.	Alesina et al. (2002)	190 countries
Log settler mortality	Log of mortality rates of soldiers, bishops and sailors stationed in the colonies between the 17^{th} and the 19^{th} centuries.	Acemoglu, Johnson and Robinson (2001)	64 countries

Table 1: Variable Description and Sources (continued)			
Variable	**Description**	**Source**	**Availability**
Linguistic fractionalization	A variable measuring the probability that two randomly selected individuals in the population speak the same "mother tongue". Calculated as one minus the Herfindahl index of language shares.	Alesina et al. (2002)	202 countries
Capital per worker: ln (K/L)	Capital stock per worker in 2000, in constant 1995 international dollars. Imputed using a perpetual inventory method using all available investment data	Penn World Tables, mark 6.1	134 countries
Human capital: ϕ(E)	Human capital index based on a piecewise linear function of total years of schooling of population aged 25 and over in 1995.	Barro and Lee (2000)	175 countries
Productivity: ln A	Total factor productivity, calculated from the decomposition of output: $\ln(Y/L) = \alpha \ln(K/L) + (1-\alpha)\phi(E) + \ln A$	Penn World Tables, mark 6.1 and Barro and Lee (2000)	133 countries
Trade volume	(Exports + Imports)/(GDP at PPP) in 1995, at constant 1985 $.	Dollar and Kraay (2002)	144 countries
Tariffs	Average of unweighted tariffs in 1990-1999 period.	Wacziarg and Welch (2002)	121 countries
Black market premium	Average black market premium in 1990-1999 period.	Wacziarg and Welch (2002)	137 countries
Surface area (in square kilometers)	Surface area (in square kilometers)	World Development Indicators, 2001	196 countries
Population	Population in 1998	World Bank Development Index, 2001	194 countries

Table 2: List of Countries by Openness Status and Degree of Corruption

	Low Corruption	Medium Corruption	High Corruption
Closed	Estonia *Total: 1 countries*	Bangladesh, Belarus, China, Croatia, Ethiopia, Guyana, India, Nepal, Romania, Rwanda, Senegal, Zimbabwe. *Total: 12 countries*	Algeria, Angola, Burundi, Central African Republic, Chad, Congo, Congo Democratic Republic (Zaire), Gabon, Haiti, Iran, Kazakhstan, Malawi, Nigeria, Pakistan, Papua New Guinea, Russia, Sierra Leone, Syria, Tanzania, Togo, Turkmenistan, Ukraine, Uzbekistan, Zambia. *Total: 24 countries*
Open	Australia, Austria, Belgium, Botswana, Canada, Chile, Costa Rica, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Malaysia, Malta, Mauritius, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Trinidad and Tobago, Tunisia, United Kingdom, United States, Uruguay. *Total: 43 countries*	Albania, Argentina, Benin, Brazil, Bulgaria, Burkina Faso, Cape Verde, Colombia, Cote d'Ivoire, Dominican Republic, Egypt, El Salvador, The Gambia, Ghana, Guinea, Jamaica, Jordan, Latvia, Lesotho, Lithuania, Madagascar, Mali, Mauritania, Mexico, Morocco, Panama, Peru, Philippines, Sri Lanka, Swaziland, Thailand, Turkey, Yemen. *Total: 33 countries*	Armenia, Azerbaijan, Bolivia, Cameroon, Ecuador, Georgia, Guatemala, Guinea-Bissau, Honduras, Indonesia, Kenya, Kyrgyzstan, FYR Macedonia, Moldova, Mozambique, Nicaragua, Niger, Paraguay, Tajikistan, Uganda, Venezuela. *Total: 21 countries*

Notes: Countries are defined to have low, medium, or high corruption based on the Kaufmann et al. (2003) graft index. Countries in the bottom third of the corruption distribution are defined as low corruption, countries in the middle third are defined as medium corruption, and countries in the top third are defined as high corruption. The openness dummy is taken from Wacziarg and Welch (2003).

Table 3: Summary Statistics

	N	Mean	Standard Deviation	Minimum	Maximum
Log GDP per capita, 1996-2003	134	8.384	1.173	6.186	10.729
Corruption, 1996-2000	134	-0.057	1.014	-2.39	1.61
Corruption, 1982	62	0.004	0.999	-1.254	2.264
Wacziarg-Welch openness dummy, 1990-1999	134	0.724	0.449	0	1
Legal origin – English	134	0.261	0.441	0	1
Legal origin – French	134	0.470	0.501	0	1
Legal origin – socialist	134	0.194	0.397	0	1
Legal origin – other	134	0.075	0.264	0	1
Fraction English speakers	134	0.064	0.226	0	0.984
Fraction European language speakers	134	0.256	0.406	0	1
Ethnic fractionalization	133	0.442	0.259	0.002	0.930
Linguistic fractionalization	130	0.398	0.294	0.002	0.923
Log settler mortality	61	4.648	1.282	2.146	7.986
Log (K/L)	126	9.883	1.543	6.302	12.311
$\psi(E)$ (Human Capital)	134	0.696	0.309	0.092	1.224
Log(A)	126	5.575	0.548	4.058	6.788
Trade Volume [(IM+EX)/GDP]	127	0.433	0.425	0.037	2.876
Average unweighted tariff	118	15.073	9.392	0.32	54.73
Black market premium	130	418.013 (Median = 5.25)	4470.29	-0.35	50,979.7
Latitude	134	0.308	0.200	0	0.722
Percentage Catholic	134	34.095	36.668	0	97.3
Percentage Protestant	134	12.417	21.063	0	97.8
Percentage Muslim	134	20.583	33.082	0	99.5
Log area (square miles)	132	12.234	1.857	5.768	16.655
Log population	134	16.179	1.512	12.521	20.938

Note: The full sample of 134 countries includes all countries with non-missing data on GDP per capita, corruption and openness in the 1990s based on the Wacziarg-Welch indicator.

Table 4: Corruption, Openness and Output
Basic OLS Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Full Sample	Full Sample	Africa	Asia/Oceania	Europe	Excluding OECD	Corruption Index > 0	Corruption measured imprecisely
Corruption	-0.961 (-3.19)	-0.280 (-1.22)	-0.461 (-1.17)	0.364 (0.90)	-0.484 (-2.63)	-0.280 (-1.20)	-0.237 (-0.81)	0.057 (-0.16)
Corruption × Openness	0.041 (0.13)	-0.522 (-2.22)	-1.070 (-2.27)	-1.260 (-2.99)	-0.236 (-1.22)	-0.683 (-2.69)	-0.955 (-2.47)	-1.009 (-2.75)
Openness	0.159 (0.65)	0.550 (1.93)	0.601 (1.58)	0.747 (2.06)	-0.175 (-1.65)	0.593 (2.07)	0.593 (1.75)	0.691 (2.17)
Continent Dummies	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F test for $\beta_{corruption} + \beta_{corr \times open} = 0$	331.79 (0.00)	250.62 (0.00)	34.01 (0.00)	53.99 (0.00)	129.58 (0.00)	91.57 (0.00)	22.02 (0.00)	68.35 (0.00)
N	134	134	42	27	41	104	85	47
R^2	0.691	0.826	0.504	0.766	0.839	0.715	0.606	0.795

Notes: The dependent variable is the log of average GDP per capita between 1996and 2003. The continent dummies are dummies for Europe, North America, South America, and Asia/Oceania. The omitted continent is Africa. Robust t-statistics in parentheses.

Table 5: Robustness Checks

	(1) Corruption in the 1980s	(2) Corruption in 1996	(3) Corruption in 1998	(4) Corruption in 2000	(5) Additional variable: Latitude	(6) Additional variable: religion dummies	(7) Additional variable: log population	(8) Additional variable: log area
Corruption	-0.274 (-1.59)	-0.444 (-1.75)	-0.209 (-0.92)	-0.059 (-0.33)	-0.241 (-1.39)	-0.402 (-1.80)	-0.277 (-1.23)	-0.422 (-1.56)
Corruption × Openness	-0.284 (-1.50)	-0.385 (-1.49)	-0.532 (-2.29)	-0.698 (-3.77)	-0.553 (-3.04)	-0.419 (-1.81)	-0.525 (-2.27)	-0.371 (-1.34)
Openness Dummy	0.163 (0.66)	0.134 (0.38)	0.700 (2.65)	0.712 (2.76)	0.795 (3.02)	1.047 (2.67)	-1.281 (-1.04)	2.153 (2.77)
Additional Variable	-	-	-	-	2.288 (1.18)	See footnote	-0.082 (0.07)	0.115 (0.06)
Additional Variable × Openness	-	-	-	-	-2.145 (1.25)	See footnote	0.114 (0.08)	-0.135 (0.07)
F test for $\beta_{corruption} + \beta_{corr \times open} = 0$	49.73 (0.00)	231.09 (0.00)	238.92 (0.00)	238.32 (0.00)	197.51 (0.00)	178.50 (0.00)	253.02 (0.00)	232.60 (0.00)
N	57	125	134	134	134	133	134	132
R^2	0.733	0.797	0.818	0.827	0.835	0.844	0.830	0.826

Notes: The dependent variable is the log of average GDP per capita between 1995 and 1999. Robust t-statistics in parentheses.

*: In column (6), the coefficients on the religion variables are: fraction catholics 0.749 (0.584); fraction protestants 0.210 (0.336); fraction Muslim 0.621 (0.411); fraction catholic × openness –0.611 (0.610); fraction protestant × openness –0.670 (0.418); fraction Muslim × openness –1.009 (0.487).

Table 6: Instrumenting for Corruption

	(1)	(2)	(3)	(4)	(5)
Corruption	2.723 (1.07)	-2.648 (-2.48)	-0.500 (-0.32)	-2.384 (-1.41)	-0.671 (-0.69)
Corruption × Openness	-3.540 (-1.39)	1.851 (1.73)	-0.657 (-0.42)	0.542 (0.38)	-0.525 (-0.53)
Openness Dummy	2.918 (1.45)	-1.314 (-1.53)	0.471 (0.37)	-0.606 (-0.46)	0.146 (0.891)
F test for $\beta_{corruption} + \beta_{corr\times open} = 0$	182.23 (0.00)	86.90 (0.00)	40.43 (0.00)	13.70 (0.00)	38.60 (0.00)
N	134	134	133	130	61
Instrument type	Legal origin	Languages	Ethnic fractionalization	Linguistic fractionalization	Log settler mortality
First Stage F- test: Corruption	36.65	8.35	7.83	2.63	12.20
First Stage F- test: Corruption × Openness	60.59	8.73	8.12	2.63	12.50
Overid. Test	1.331 (0.72)	4.067 (0.13)	-	-	-

Notes: The dependent variable is the log of average GDP per capita between 1996 and 2003. Robust t-statistics in parentheses. All regressions include continent dummies and their interaction with the openness variable. The instrument set includes the set of exogenous variables, and these variables interacted with the openness dummy.

Table 7: Instrumenting for Corruption *and* Openness

	(1) Africa	(2) Asia/Oceania	(3) Europe
Corruption	-2.959 (-1.29)	0.438 (0.19)	0.580 (0.21)
Corruption × Openness	2.782 (0.71)	-1.368 (-0.52)	-0.944 (-0.35)
Openness Dummy	-1.089 (-0.61)	0.819 (0.59)	2.516 (1.40)
F test for $\beta_{corruption} + \beta_{corr\times open} = 0$	0.00 (0.944)	8.25 (0.004)	11.52 (0.001)
N	42	27	41
First Stage F- test: Corruption	1.68	1.82	20.41
First Stage F- test: Openness	1.36	1.25	1.23
First Stage F- test: Corruption × Openness	0.53	1.99	18.52
Overidentification Test	-*	5.400 (0.249)	2.731 (0.604)

Notes: The dependent variable is the log of average GDP per capita between 1996 and 2003. Robust t-statistics in parentheses. The instrument set includes three legal origin dummies, the Frankel-Romer index, and their interactions.

* : In Africa there are only two types of legal origins, English and French. Therefore, the instrument set includes only one legal origin dummy, and the model is exactly identified.

Table 8: Corruption and the Decomposition of Output into its Components

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Full Sample	Full Sample	Full Sample	Corruption Index > 0	Corruption Index > 0	Corruption Index > 0
Dependent variable	Capital per worker: ln(K/L)	Human capital: $\psi(E)$	Productivity: ln A	Capital per worker: ln(K/L)	Human capital: $\psi(E)$	Productivity: ln A
Corruption	0.667 (1.42)	0.134 (1.25)	-0.320 (-1.91)	0.979 (1.73)	0.198 (1.49)	-0.372 (-1.62)
Corruption × Openness	-1.440 (-3.05)	-0.231 (-2.12)	-0.066 (-0.38)	-1.854 (-2.77)	-0.227 (-1.37)	-0.244 (-0.81)
Openness	1.072 (2.05)	0.128 (1.33)	0.283 (1.75)	0.924 (1.52)	0.084 (0.68)	0.262 (1.27)
N	126	126	126	78	78	78
R^2	0.807	0.712	0.591	0.696	0.647	0.388

Notes: The dependent variable is specified at the top of each column. All regressions include continent dummies, and their interaction with the openness variable. Robust t-statistics in parentheses. For explanations on the construction of the dependent variables, see text.

Table 9: Corruption, Financial Openness and Trade Openness

Sample Openness Measure	(1) Full Sample Open if trade volume ≥ median	(2) Full Sample Trade volume, continuous	(3) Full Sample Open if average tariff ≤ 20%	(4) Full Sample Average tariff, continuous	(5) Full Sample Open if BMP<=20%	(6) Full Sample BMP, continuous
Corruption	-0.807 (-6.73)	-0.952 (-11.90)	-1.301 (-6.38)	-2.496 (-3.42)	-0.371 (-1.49)	-0.434 (-0.67)
Corruption × Openness	0.141 (1.03)	0.584 (4.20)	0.621 (2.96)	1.932 (2.50)	-0.407 (-1.58)	-0.349 (-0.53)
Openness	0.369 (2.82)	1.151 (5.14)	-0.358 (-2.07)	-0.368 (-0.45)	0.427 (1.46)	0.009 (0.02)
F test for $\beta_{corruption} + \beta_{corr \times open} = 0$	100.13 (0.00)	13.83 (0.00)	146.97 (0.00)	63.08 (0.00)	205.60 (0.00)	205.39 (0.00)
N	127	127	118	118	130	130
R^2	0.844	0.863	0.852	0.846	0.823	0.820

Notes: The dependent variable is the log of average GDP per capita between 1996 and 2003. All regressions include continent dummies, and their interaction with the openness variable. Robust t-statistics in parenthesis.