KYKLOS, Vol. 56 – 2003 – Fasc. 4, 457–474

How Corruption Affects Productivity

Johann Graf Lambsdorff*

I. INTRODUCTION

Corruption is likely to lower the productivity of capital due to a variety of channels. Corruption renders governments incapable or unwilling to achieve public welfare as a result of x-inefficiency, wasteful rent-seeking or distorted public decisions (Bardhan 1997, Rose-Ackerman 1999, Lambsdorff 2002a). The allocation of capital goods will not be optimal when affected by corruption because those projects that promise large side-payments and exhibit low risks of detection are preferred to those that benefit the public at large. The best-connected contractors and those most willing to offer bribes are preferred to those offering the best product. The quality of investments will suffer from corruption because control mechanisms, required to guarantee the contracted quality level, can be circumvented. Public servants are appointed based on nepotism or bribe payments while aspects of efficiency and capacity are disregarded. The effort level of public servants suffers from adverse incentives because creating artificial bottlenecks can increase the need for paying speed-money. The most visible sign of the adverse impact of corruption are 'white-elephant projects', that is, projects that totally disregard public demand or that are wrecked shortly after completion (Mauro 1997).

There exists strong empirical support for the adverse impact of corruption on the ratio of investment to GDP (Mauro 1995 and 1997, Knack and Keefer 1995, Campos, Lien and Pradhan 1999, Brunetti, Kisunko and Weder 1997: pp. 23, 25 and Brunetti and Weder 1998: pp. 526, 528). Equally there is substantial evidence for an adverse impact of corruption on foreign direct investments and capital inflows (Wei 2000, Lambsdorff 2003). But there exists no

* The author holds a chair position in economic theory at the University of Passau, Innstrasse 27, D-94032 Passau, Germany, jlambsd@uni-passau.de. He is primarily grateful to Guy Pfeffermann for sharing the initial thoughts leading to this paper. Thanks also to H. Davoodi, W. Easterly, G. Engel, A. K. Jain, H.-J. Jarchow, P. Mauro, H. Möller, S. Rose-Ackerman, C. Schinke, V. Tanzi and S. U. Teksoz for providing helpful comments.

equal empirical support for the likely adverse impact of corruption on productivity.

Corruption was shown to reduce growth (Mo 2001, Leite and Weidmann 1999: p. 24, Poirson 1998: p. 16, Knack and Keefer 1995, Mauro 1997: p. 92). But this evidence is still ambiguous because other researchers provide inconclusive results (Brunetti, Kisunko and Weder 1997: pp. 23, 25). Mauro's (1995) results are insignificant once the regressions are controlled for the ratio of investment to GDP. Wedeman (1997) uses simple cross tabulation to argue that many corrupt countries experienced high growth rates. It is arduous, it seems, to reliably relate growth to corruption. But even when assuming an impact of corruption on growth, this does not allow conclusions with regard to productivity. In case corruption lowers productivity, there still might be no effect on growth. We might regard the absence of corruption as a factor of production, comparable to human capital. Corruption (and its absence) does not change quickly from year to year. Investments undertaken in the past will suffer from corruption (or prosper from integrity) just as more recent investments will be affected. Subsequently, while a new investment project produces higher output for corruption-free countries, there is not necessarily an increase in growth. Growth is measured as changing GDP relative to absolute levels of GDP. But both values, changing GDP and its absolute level, will equally gain from a corruption-free environment so that their ratio may remain constant. Steady-state growth rates, as determined in neoclassical growth models, are therefore unaffected by singular productivity shifts.

Thus, the (ambiguous) evidence on the link between corruption and growth does not help in an analysis of corruption and productivity. Other approaches are needed to relate these two variables. Tanzi and Davoodi (1997) provide such a contribution by examining the impact of corruption on the quality of investments. Referring to panel data on corruption for 1980–95, the authors suggest that corruption lowers the quality of the infrastructure as measured by the condition of paved roads and power outages. They support their hypothesis by reporting a high significance in their statistical results[1]. Isham and Kaufmann

1. Based on own regressions for a cross-section of countries and using the Transparency International Corruption Perceptions Index 2001 (TI CPI 2001) it was not possible to reproduce significant results. This sheds some doubt on the robustness of the findings to different methodologies. Also, the corruption index used by Tanzi and Davoodi (1997) is the one from the International Country Risk Guide (ICRG). This indicator does not measure corruption but the political risk associated with corruption. As explained by ICRG's editor in personal correspondence, the political risk measured by ICRG not only increases with levels of corruption but also with intolerance towards corruption. Various researchers have misleadingly interpreted the ICRG data on corruption.

(1999) and the World Bank (1997: p. 39) present an alternative approach. They correlate the economic rate of return on World Bank-financed projects with indicators of institutional quality and present a positive association of these variables.

This study complements the prevalent findings by employing a macroeconomic approach: We determine productivity by the GDP to capital stock ratio, the latter being calculated with the help of a perpetual inventory method. Productivity will be regressed on corruption, proving a significant negative impact, as shown in Section II. This section also addresses endogeneity issues by using instruments. Section III decomposes corruption into various governance indicators and identifies the subcomponent that is crucial to productivity. Section IV extends the analysis by discussing sample selection issues and testing the robustness of the results, particularly by making use of alternative indices of corruption. Section V concludes and suggests avenues for future research. Appendix 1 reports correlations for the crucial variables. Appendix 2 describes the data used for this study and Appendix 3 lists the countries.

II. REGRESSION RESULTS

We determine productivity as the ratio of GDP to the capital stock; high values indicate an economy where little capital is needed to produce a large outcome and low values signify a low output in relation to capital. See Appendix 2 for a description of this and all subsequent data. *Table 1* provides regressions of productivity on corruption. We control all regressions by the capital stock per capita[2]. The capital stock enters in logarithmic terms, which was preferable with respect to heteroskedasticity. The capital stock per capita exerts a highly significant negative impact[3]. Doubling the capital stock per capita lowers productivity by 8 per cent, suggesting that the impact is large. This is evidence for the standard assumption of decreasing returns to capital (in a narrow physical

2. As shown in Appendix 1, the simple correlation coefficient between absence of corruption and capital productivity is –0.28. Contrary to our assumption this is a negative value. This should not come by surprise, because a simple correlation disregards important explanatory variables. There exists a strong positive correlation of 0.83 between 'absence of corruption' and the per capita capital stock. Diminishing returns to capital suggest that the per capita capital stock negatively impacts on productivity. But once this variable is omitted, its impact is captured by absence of corruption, resulting in a distorted value for the simple correlation.
3. GDP per capita cannot be included as an explanatory variable. Its inclusion would over-determine the dependent variable, because the capital stock per capita and GDP per capita both determine capital productivity. Influences that originate from a country's overall economic development are well captured by the capital stock per capita.

sense). Absence of corruption is positively associated with the ratio of GDP to the capital stock, indicating that corruption reduces the productivity of capital. An increase in corruption by one point on a scale from 10 (highly clean) to 0 (highly corrupt) lowers productivity by 2 percent[4].

These results also remain valid when including further explanatory variables. Africa often exhibits an outstandingly poor performance, while Asia experienced the highest growth rates in the past. Regression 2 therefore incorporates regional dummy variables, but they proved immaterial to the results. This insignificance also results for other regions (results not reported). Other plausible explanatory variables are also remarkably weak. As shown in regression 3, secondary school enrollment (as a proxy for human capital accumulation) does not reveal a significant influence. This may result from a high correlation of this variable with the capital stock per capita, where the latter variable dominates the regression. Also raw materials exports are insignificant. These are an important production factor; countries with these resources may obtain higher returns to their existing capital stock, because importing is usually more costly than extracting. A potential explanation for the poor result is that potential gains from raw materials extraction are absorbed by the military and political protection necessary to defend the proceeds or by the waste generated by competition over the given rents – an explanation which is standard in the rent-seeking literature (Lambsdorff 2002 a).

4. By superficial reflection one may suspect that our results are inconsistent with existing empirical studies. Our dependent variable, the ratio of GDP to capital (Y/K), equals $\Delta Y/\Delta K$ in the case of a constant productivity of capital over time. Rewriting this term yields $(\Delta Y/Y) \cdot (Y/\Delta K)$. As mentioned in Section I, there was only ambiguous support for an impact of corruption on growth ($\Delta Y/Y$). At the same time, the ratio of investment to GDP, ($\Delta K/Y$), has been shown by various authors to decrease with rising degrees of corruption. Thus, $(\Delta Y/Y) \cdot (Y/\Delta K)$ might be expected to rise with higher degrees of corruption. This would suggest that the capital stock suffers more from corruption than GDP and that corruption may be positively associated with the ratio of GDP to the capital stock. But throughout the literature the results for an impact of corruption on the ratio of investment to GDP, ($\Delta K/Y$), were obtained without controlling for the capital stock per capita. Instead, they were obtained by controlling for GDP per capita. The choice of the control variable is essential to the results of the regressions. It can be shown that corruption is positively and significantly correlated with the ratio of investment to GDP as soon as the capital stock per capita is inserted as a control variable. Such regressions have been carried out but the results are not explicitly reported there. These results reconcile standard empirical findings with the approach taken here.

Table 1

Dependent Variable: Productivity, measured by the Ratio of GDP to Capital Stock, 2000[a)]

Independent Variable	1. OLS	2. OLS	3. OLS	4. OLS	5. TSLS[b)]
Constant	1.49 (7.9)	1.58 (6.8)	1.54 (7.1)	1.46 (5.3)	1.57 (5.2)
Absence of corruption (TI CPI 2001)	0.020 (3.3)	0.019 (3.4)	0.017 (2.8)	0.017 (2.9)	0.024 (2.0)
Capital Stock per Capita, log.	−0.080 (−5.5)	−0.085 (−5.0)	−0.082 (−4.7)	−0.077 (−3.8)	−0.087 (−3.5)
Sec. School Enr. 1990−95			0.01 (0.2)	0.01 (0.1)	
Export of Fuels and Minerals			−0.09 (−1.3)	−0.08 (−1.2)	
Openness, Contr. for Pop.			−0.08 (−2.0)	−0.08 (−1.9)	
Invest. to GDP Price Deflator				0.01 (0.4)	
Africa, dummy variable		−0.03 (−0.9)			
Asia, dummy variable		−0.04 (−1.5)			
Obs.	69	69	56	56	69
R^2	0.36	0.38	0.48	0.49	0.36
Jarque-Bera[c)]	3.4	7.0	3.1	2.7	3.3

Notes: a) White corrected t-statistics are in parenthesis. b) Share of Protestants are used as instrument for absence of corruption. c) The Jarque-Bera measures whether a series is normally distributed by considering its skewness and kurtosis. The assumption of a normal distribution can be clearly rejected for levels above 6.

Capital productivity might be assumed to increase with a country's openness, because international competition induces an efficient use of resources. However, contrary to our intuition, openness was found to lower productivity. This result should not be overrated because it is largely driven by one single country, Malaysia, which has a very high level of openness. The result may also be reconciled with intuition when considering that countries with a high level of openness are successful in attracting capital. The higher capital stock may bring about a lower average productivity of capital. Closed economies, on the other hand, might deter private investments and the few that are undertaken must be encouraged by high returns. It could arise that this impact is not perfectly captured by our variable on capital per capita.

What we have measured may relate only to a nominal price effect of corruption, not a real effect on productivity. This price effect can arise when investment goods become more expensive due to corruption and when their book value exceeds their real value. Controlling for the investment price deflator, as in regression 3, provides a test for the existence of this effect. Increases in this variable are supposed to raise the costs of physical capital and thus reduce the ratio of GDP to the capital stock. But the variable is insignificant and its inclusion did not alter the impact of our corruption variable. This might be due to consumption goods being equally inflated by corruption as investment goods. Thus, the nominal impact on the capital stock is equal to that on GDP and there is no impact on the ratio of these two variables. The impact of corruption on the ratio of GDP to capital cannot be explained by a purely nominal impact on the price for investment goods. We use *Table 1*, regression 1 as our benchmark regression for the subsequent analysis, because all variables obtained the expected sign and were significant.

What remains to be clarified is whether the causality indeed runs from corruption to low productivity. One may hypothesize, for example, that some countries are rated corrupt because they perform poorly in economic terms. What appears equally pressing is whether important variables had been omitted. If such variables exist and correlate with corruption, the resulting coefficients would be biased. Also measurement errors of our corruption variable would bring about biased results. All these problems, causality, omitted variables and measurement error, can be avoided by finding adequate instruments that well correlate with corruption but not with the error term of our regression. We employ here the share of Protestants in a country[5]. Countries with a large share of Protestants have been found to exhibit lower levels of corruption (Treisman 2000, Paldam 2001, Lambsdorff 2002b). The argument is that Protestantism is a less hierarchical religion, where individuals are less embedded in networks that pursue the material benefit of their members at the expense of society at large. Such an embeddedness otherwise represents a breeding ground for corruption by helping in the enforcement of illegal agreements (Lambsdorff 2002c). This instrument has a significant impact on corruption but does not correlate with the error term of our benchmark regression. This suggests that its impact on productivity runs primarily via its effect on corruption. As shown in regression 4, *Table 1*, the impact of absence of corruption on productivity survives the use of this instrument.

5. We tested also other variables for their use as instruments, e.g., ethnolinguistic fractionalization, used by Mauro (1995). However, this variable did not significantly impact on corruption in the first step of TSLS.

III. IDENTIFYING CHANNELS OF INFLUENCE

Corruption includes many different types of behavior. The reasons for its adverse effect on productivity can therefore be manifold. The channels of influence can be identified by decomposing corruption into governance-related subcomponents. In particular these are civil liberties, government stability, law and order and bureaucratic quality. The relevant data, as described below, are from Gastil (1986) and the International Country Risk Guide (ICRG)[6].

Bureaucratic quality signals an administration that is autonomous from political pressure, that uses established mechanisms for recruiting and training and where government services are characterized by strength and expertise. If such characteristics are missing, public servants may create artificial bottlenecks so as to increase their corrupt income. Once corruption becomes embedded, the bureaucracy is less concerned with expertise and open to political pressure. As a result, corruption can go along with bureaucratic inefficiency.

Government stability is an assessment of the government's aptitude to carry out its declared programs and its ability to stay in office. These goals can be achieved with a high level of government unity, strong legislative power and popular support for the government. A strive for corrupt income among politicians is commonly in contrast to the declared program, it reduces popular support and threatens the ability to stay in office. Therefore, corruption undermines government stability.

Law and order indicates that a country has sound and accepted political institutions, a strong court system and provisions for an orderly succession of power. This can be seriously violated in case of corruption. If judicial decisions and laws can be bought for a price a country cannot develop a tradition of law and order. An orderly succession of power is substituted for a system where power can be bought.

Civil liberties, finally, comprise the freedom of expression and belief, personal autonomy as well as human and economic rights. A government that limits economic rights and civil liberties tends to distort markets, inducing the search for illegal ways to circumvent regulation. This creates opportunities for corruption.

Government Stability is measured on a scale from 0 (worst) to 12 (best) with the worst score of 5 actually assigned to a country in our sample; Law and Order is given on a scale from 0 to 6, Bureaucratic Quality from 0 to 4 and Civil Liberties from 7 to 1. As shown in *Table 2*, these variables capture a good deal of our corruption variable. A significant impact, as reported in *Table 2*, is ex-

6. We use the May 1998 data by ICRG, The PRS Group, East Syracuse, NY, USA.

erted by government stability, law and order, bureaucratic quality and civil liberties, alas, the latter partly via its correlation with the capital stock per capita[7]. Also further governance indicators have been tested, but they did not significantly impact on corruption.

Table 2

OLS, Dependent Variable: TI Corruption Perceptions Index 2001

Independent Variables	1.	2.
Constant	−2.27	−9.34
	(1.7)	(−3.7)
Capital Stock per Capita, log.		0.569
		(3.2)
Government Stability (ICRG)	0.24	0.23
	(2.3)	(2.7)
Law and Order (ICRG)	0.56	0.47
	(5.3)	(4.2)
Bureaucratic Quality (ICRG)	1.23	0.88
	(7.8)	(4.7)
(Lack of) Civil Liberties, Gastil, 1985	−0.26	−0.17
	(−3.1)	(−1.8)
Obs.	78	70
R^2	0.80	0.82
Jarque-Bera	1.8	0.8

As can be observed from *Table 3*, three of the variables formerly identified are significant, namely government stability, bureaucratic quality and civil liberties. Interestingly, law and order is irrelevant to productivity[8].

Bureaucratic quality exerts a significant impact. Once included, it captures a significant portion of the former impact of corruption, rendering this variable insignificant. A one-point increase in bureaucratic quality increases productivity by almost 5 percent. This impact is in line with related evidence. For example, Kaufmann and Wei (1999) proved that levels of corruption are positively associated with the time managers waste with bureaucrats. This waste of time directly reduces productivity. The impact of government stability is mostly sig-

7. Unlike in Lambsdorff (2003) the second regression controls for the capital stock per capita instead of GDP per capita because this variable is also used in our subsequent regressions. This modification was without noteworthy differences to the results.
8. The sample of countries has slightly decreased from 69 to 67 countries. However, the values reported in *Table 1*, regression 1 are equal to those obtained with this restricted sample, allowing for direct comparisons.

Table 3

Least Squares Regressions Dependent Variable: Productivity, measured by the Ratio of GDP to Capital Stock, 2000

Independent Variables	1.	2.	3.	4.	5.	6.
Constant	1.37	1.65	1.51	1.76	1.74	1.66
	(6.6)	(8.0)	(8.1)	(7.7)	(7.6)	(7.3)
Absence of Corruption	0.019	0.009	0.024	0.015	0.007	
(TI CPI 2001)	(3.1)	(1.2)	(2.6)	(2.6)	(0.7)	
Capital Stock per Capita, log.	–0.078	–0.096	–0.080	–0.092	–0.106	–0.102
	(–5.5)	(–5.7)	(–5.4)	(–5.8)	(–6.1)	(–5.7)
Government Stability (ICRG)	0.011				0.017	0.019
	(1.6)				(2.5)	(3.1)
Bureaucratic Quality (ICRG)		0.048			0.051	0.058
		(2.0)			(2.1)	(2.8)
Law and Order (ICRG)			–0.010		–0.012	–0.008
			(–0.6)		(–0.8)	(–0.6)
(Lack of) Civil Liberties,				–0.021	–0.020	–0.021
Gastil 1985				(–2.4)	(–2.6)	(–2.6)
Obs.	67	67	67	67	67	67
R^2	0.37	0.41	0.37	0.42	0.50	0.50
Jarque-Bera	2.7	2.1	3.5	9.7	1.8	1.6

nificant. This must be seen in light of the variable's definition: A high level of government unity, strong legislative power and popular support for the government are crucial to this variable. It appears likely that a good performance in this respect can only be achieved when governments avoid the wasting of resources and abstain from giving preferential treatment to individuals – activities that lower productivity. Lack of civil liberties obtains a negative impact on productivity – in line with our expectations. This impact may refer to the fact that absent civil liberties often go along with cumbersome regulation and market distortions. These adversely affect productivity, e.g. by bringing about an inefficient allocation of resources. Inclusion of the latter two variables, however, does not lower the impact of corruption. This suggests that they are important per se, but not primarily because they correlate with corruption.

The irrelevance of law and order is noteworthy. One may have assumed that a tradition of law and order sufficiently restricts politicians and bureaucrats in arranging shady deals that disregard efficiency and productivity. But law and order may also bring about excessive regulation and impede the functioning of market forces. It may therefore also impede productive activities.

The results obtained here must be seen against a related investigation of the impact of corruption on capital inflows (Lambsdorff 2003). The impact of the sub-components obtained there was opposite to the one obtained here. Bureaucratic Quality, Civil Liberty and Government Stability were found to be irrelevant to capital inflows, whereas a country's Law and Order tradition was significant. Above that, a tradition of law and order captured a fraction of the influence exerted by corruption. Tying politicians' hands by the rule of law is important in attracting foreign capital, but it helps little in increasing productivity.

IV. ROBUSTNESS AND SAMPLE SELECTION

Corruption is commonly difficult to measure. Indices that gather perceptions of business people and country analysts appear to be good proxies for real levels of corruption. The 2001 Transparency International Corruption Perceptions Index (TI CPI 2001) employs this approach. It is a composite index, using data from 7 independent institutions. The high correlation among the sources provides confidence in the validity of the data. But some differences between the various sources can be observed. The results from *Table 1* can be checked against the usage of different indices of corruption. We will employ 5 different indices. These are the ones used for compiling the TI CPI 2001 and cover a sufficient number of countries. They are the World Economic Forum's (WEF) Global Competitiveness Report and Africa Competitiveness Report, The World Bank's (WB) Business Environment Survey, PricewaterhouseCoopers' (PwC) Opacity Index, The Institute for Management Development's (IMD) World Competitiveness Report, and the Country Risk data by the Economist Intelligence Unit (EIU). All data were compiled in 2000 or 2001 and are re-scaled to obtain the same mean and standard deviation as the corresponding sub-sample of countries in the TI CPI 2001. Thus, results are directly comparable to the ones in *Table 1*. A comprehensive description of the data is provided in Lambsdorff (2001b). As shown in *Table 4*, there are some differences to be found, depending on which corruption index has been used. But only in one case, when making use of the data by the World Bank, the result is no longer significant at conventional levels. This largely corroborates the robustness of the findings.

Table 4

OLS, Dependent Variable: Ratio of GDP to Capital Stock, 2000

Independent Variable	1.	2.	3.	4.	5.	6.
Constant	1.32 (4.9)	1.26 (7.4)	1.34 (6.6)	1.60 (8.7)	1.35 (5.5)	1.66 (3.6)
Capital Stock per Capita, log.	−0.066 (−3.5)	−0.063 (−4.7)	−0.066 (−4.1)	−0.090 (−6.3)	−0.070 (−3.8)	−0.089 (−2.6)
Absence of Corruption (IMD 2001)	0.015 (3.2)					
Absence of Corruption (WEF 2001)		0.014 (2.1)				
Absence of Corruption (WB 2001)			0.010 (1.3)			
Absence of Corruption (EIU 2001)				0.027 (4.5)		
Absence of Corruption (PwC 2001)					0.022 (2.2)	
Absence of Corruption (ICVS 1997)						0.017 (1.7)
Obs.	39	78	54	79	26	23
R^2	0.19	0.25	0.32	0.40	0.26	0.39
Jarque-Bera	7.1	4.3	1.8	2.1	1.8	1.0

With less than 70 countries included in the regressions many countries in the world were disregarded. Because investors (for whom indices on governance are commonly compiled) are barely interested in countries that are either small or corrupt, our sample is not picked at random. Regression analysis, for example, reveals a significant and positive relationship between corruption and population, simply because small and corrupt countries are disregarded by institutions that provide data to investors, Knack and Azfar (2003). While this relationship is distorted, there exists no argument whether the sample selection might also distort our results on productivity. The sample selection bias is not equally relevant for all of the sources used. It is particularly relevant for the data by IMD and PwC, which include particularly rich countries. But it is less relevant for the other sources that cover also many low-income countries. It is thus interesting that our results also hold for such samples of countries. This suggests that aspects of sample selection are not crucial to the results.

The index on corruption relates to subjective assessments by business people and country analysts. The various different approaches and samples used in sur-

veys of business people, combined with the fact that the results correlate strongly, commonly provide some confidence that subjective assessments are good proxies for real levels of corruption (Lambsdorff 2001 b). Still, the idea that personal attitudes may overshadow responses and introduce a measurement error is difficult to disprove totally. Another test is to employ the data on corruption determined by the International Crime Victim Survey (ICVS). This survey was carried out in 1996/97. It polled the general public, asking whether respondents had been personally asked or have been expected to pay a bribe. The assessments represent experience and are not overshadowed by other factors related to subjective circumstances and attitudes[9]. At first, it can be noted that the other indices on corruption correlate well with the one by ICVS. This suggests that a measurement error related to personal attitudes cannot be observed in the corruption data used. Introducing the index by ICVS into our regressions provides another confirmation. The result is given in *Table 4*, regression 6. The coefficient for absence of corruption barely misses to be significant at conventional levels. This can easily arise due to the smaller sample of countries. At the same time the impact of absence of corruption remains large in magnitude, comparable to the values obtained in other regressions. Overall, this result supports our findings.

V. CONCLUSIONS AND POLICY RECOMMENDATIONS

Contemporary empirical investigations insufficiently link corruption to low productivity. This study establishes such a link. A macroeconomic approach to the productivity of capital has been used, namely the ratio of GDP to the capital stock, with the latter being determined by a perpetual inventory method. Controlling for the total capital stock per capita, a variety of regressions were carried out. There was repeated support for corruption lowering the productivity of capital. An increase in corruption by one point on a scale from 10 (highly clean) to 0 (highly corrupt) lowers productivity by 2 percent. An improvement with regard to corruption by 6 points of the Transparency International Corruption Perceptions Index – for example Tanzania improving to the level of the United Kingdom – increases GDP by more than 10 per cent of the total capital stock. Because the capital stock is, on average, roughly twice the value of GDP,

9. The data by ICVS is distributed differently than the other ones. To make its impact comparable to that of the other variables, it has been standardized with a matching percentiles-technique, where the Transparency International Corruption Perceptions Index served as the master index. The data can be obtained from: http://ict-law.leidenuniv.nl/group/jfcr/www/icvs/.

the income level would hence rise by about 20 percent. Had the investments in Tanzania been undertaken at the low level of corruption that prevails in the United Kingdom, the total output would have been 20 percent higher.

Corruption was decomposed into sub-components: Bureaucratic Quality, Civil Liberty, Government Stability and Law and Order. While law and order was irrelevant, bureaucratic quality, civil liberty and government stability obtain a significant and positive impact on productivity. Once including bureaucratic quality into the regressions, the influence exerted by corruption becomes insignificant. This suggests that the adverse impact of corruption on productivity largely runs via its correlation with lacking bureaucratic quality. This result must be seen against the findings in Lambsdorff (2003). It was shown there that a country's law and order tradition is the crucial sub-component of corruption for attracting capital inflows, while the other variables are irrelevant. Anti-corruption reform strategies should be fine-tuned, depending on whether countries are primarily concerned with increasing productivity or attracting foreign capital. Public sector reform in contrast to legal reform should be given priority if countries attempt to increase productivity.

APPENDIX 1: CORRELATIONS

Table A1

Correlations

Correlation Matrix	Productivity (Ratio of GDP to Capital)	Capital Stock per capita (log.)	Absence of Corruption (TI CPI 2001)	Government Stability (ICRG)	Bureaucratic Quality (ICRG)	Law and Order (ICRG)	(Lack of) Civil Liberties (Gastil)
Productivity (GDP to Capital)	1	−0.54	−0.28	0.15	−0.24	−0.33	0.04
Capital Stock per capita (log.)	−0.54	1	0.83	0.04	0.81	0.66	−0.62
Absence of Corruption (TI CPI 2001)	−0.28	0.83	1	0.13	0.85	0.75	−0.66
Government Stability (ICRG)	0.15	0.04	0.13	1	−0.02	0.06	−0.04
Bureaucratic Quality (ICRG)	−0.24	0.81	0.85	−0.02	1	0.66	−0.63
Law and Order (ICRG)	−0.33	0.66	0.75	0.06	0.66	1	−0.47
(Lack of) Civil Liberties (Gastil)	0.04	−0.62	−0.66	−0.04	−0.63	−0.47	1

APPENDIX 2: THE DATA

The productivity of capital is determined by a macroeconomic approach. For a single project the average capital productivity is the ratio between the output generated and the capital input. Aggregating all these data for a whole nation yields a country's total average capital productivity. These aggregates are equal to the ratio of GDP to the total capital stock. The latter is determined here by a perpetual inventory method. This is carried out by computing a truncated capital stock (K'_{2000}) resulting from the real investments undertaken after the end of the Bretton Woods system, i.e. the 27 years from 1974 until 2000, assuming a depreciation rate of 7 percent[10]. By employing data from these years, those countries with highly increasing investments would be unfairly treated as compared to those with rather stable or decreasing investments. The truncated value has therefore been adjusted, also adding the capital given 27 years ago: $K_{2000} = K'_{2000} + (1.07)^{-27} K_{1973}$. This old capital stock (K_{1973}) is determined by introducing the assumption that capital productivity, and consequently the ratio of GDP to the capital stock, remains constant over time[11]. The old capital stock is then given by $K_{1973} = GDP_{1973}K_{2000} / GDP_{2000}$. Inserting this and solving for K_{2000} produces:

$$K_{2000} = \frac{K'_{2000}}{1 - (1.07)^{-27} GDP_{1973} / GDP_{2000}} \qquad (1)$$

With 27 years of investments already considered, this impact of the adjustment was small in magnitude[12]. The data on investment and growth have been obtained from the International Financial Statistics 2001, International Monetary Fund. Data on investments include both private and public investments. Eastern European countries did not qualify for inclusion in this study, because a politically motivated misallocation of capital was revealed during the transforma-

10. The value of 7 percent is considered to be a realistic approximation of the real world depreciation rate and was also used by Benhabib and Spiegel (1994). The authors also determine the capital stock. However, since they assume the same productivity of capital for each country, their assessment cannot be used for the purposes of this study.
11. This assumption, certainly, is open to debate. Complementary investments in human capital may have changed and at the same time the importance of capital vis-à-vis labor may have increased. Using the procedure presented here, the ratio of GDP to capital has also been determined for 1990. It was observed that the value on average for all countries hardly differed from the one for 2000. This supports the assumption of a constant ratio of GDP to capital.
12. The adjustment was particularly helpful in adequately dealing with countries whose investment data was incomplete. For example, if investment data prior to 1985 was not available, we would add $(1.07)^{-16} K_{1984}$ to K'_{2000}. Since this term is larger than $(1.07)^{-27} K_{1973}$ lack of investment data does not result in smaller assessments of the capital stock.

tion process and the capital stock had experienced a further depreciation. Therefore, the data prior to the transformation does not have statistical value. With the help of the data thus obtained the average capital productivity is determined by GDP_{2000}/K_{2000}. Likewise, a country's capital stock per capita is denoted by $K_{2000}/GDP_{2000} \cdot GDP_{head}$. Data on GDP per capita are for 1999 and ppp-adjusted. They were taken from the World Development Indicators 2001.

Secondary school enrollment is the average value between 1990 and 1995, as determined by the World Development Indicators 1996. Where not available the data have been substituted by the latest available year. Data on raw materials exports were determined according to the World Development Indicators 1996. The data represent the average export of fuels and minerals between 1975 and 1992 in relation to GDP[13]. This variable was considered to best describe the total contribution to a country's output of raw material extraction. The ratio between investment prices and the overall GDP deflator are average data for 1980–92. The data were obtained from the Penn World Tables. A country's openness is commonly defined as the ratio between a country's trade volume (exports plus imports) and GDP. Competitive markets might be in a better position to allocate capital goods to their most productive uses, resulting in increased capital productivity. However, a country's openness decreases with its size, measured for example by total population. The larger a country, the more of its trade is domestic and not with foreign countries. Export plus import over GDP thus misrepresent the competitive pressure faced by a country. This misrepresentation can be corrected by regressing total population on openness, introducing also a dummy for the trading centers Hong Kong and Singapore, whose trade volume is inflated by re-exported goods. All data have been taken from the World Penn Tables. Instead of using the degree of openness as such, the residuals resulting from this regression have been taken as a corrected value for a country's openness.

The level of corruption is determined by the Transparency International Corruption Perceptions Index 2001 (TI CPI 2001). This composite index compares levels of corruption, defined as the misuse of public power for private benefit, embracing petty and grand forms of corruption. The TI CPI 2001 is based on expert assessments obtained from surveys of business people and country analysts. The scores range from 0 (highly corrupt) to 10 (highly clean). While Finland scores best with 9.9, the worst performance among the 91 countries included is assigned to Bangladesh with a score of 0.4. The average score

13. In the case of Singapore, re-exports of fuels and minerals may explain the large value reported in the statistics. Since expenses for imports will lower GDP, such re-exports will not increase GDP. The value for raw materials exports for Singapore was artificially set at zero.

is 4.2. Including a country requires that at least three sources are available, resulting in reliable assessments.

APPENDIX 3: LIST OF COUNTRIES

The 69 countries included in regression 1, *Table 1*, are: Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Germany, Ghana, Greece, Guatemala, Honduras, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kenya, Malawi, Malaysia, Mauritius, Mexico, Namibia, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Peru, Philippines, Portugal, Senegal, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Kingdom, USA, Uruguay, Venezuela, Zambia, Zimbabwe.

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SUMMARY

While there is strong support for corruption reducing investment, there exists only scant empirical evidence for the likely adverse impact on productivity. This study measures productivity by the ratio of GDP to the capital stock, the latter being determined by a perpetual inventory method. A reduction of Tanzania's level of corruption to that of the United Kingdom would increase productivity by 10 percent, leading to a 20 percent increase in GDP. Decomposing this impact reveals that bureaucratic quality is the crucial determinant, but a country's tradition of law and order is irrelevant for productivity.

ZUSAMMENFASSUNG

Während ein negativer Einfluss von Korruption auf die Investitionstätigkeit hinreichend belegt ist, existieren nur spärliche Hinweise auf einen ebenso wahrscheinlichen negativen Einfluss auf die Produktivität. Diese Studie misst die Produktivität als Quotient aus BIP und Kapitalstock, wobei der letztere durch eine *perpetual inventory*-Methode bestimmt wird. Eine Verringerung der Korruption in Tansania auf das Niveau des Vereinigten Königreichs würde die Produktivität von Tansania um 10 Prozent erhöhen, was mit einem Anstieg des BIP um 20 Prozent einhergeht. Eine Zerlegung die-

ses Einflusses zeigt, dass die Qualität der Bürokratie die entscheidende Einflussgröße ist, wohingegen eine rechtsstaatliche Tradition irrelevant für die Produktivität ist.

RÉSUMÉ

Tandis qu'il est prouvé que la corruption influence l'investissement de façon négative, il existe seulement une évidence empirique limitée quant à un impact défavorable sur la productivité. Cette étude mesure la productivité par la proportion du PDB par rapport au stock de capital, ce dernier étant déterminé par une méthode d'inventaire perpétuel. En réduisant le niveau de corruption de la Tanzanie à celui du Royaume-Uni, la productivité tanzanienne augmenterait de 10 pour cent. Ceci augmenterait le PDB de 20 pourcent. La décomposition de cet impact montre que la qualité de la bureaucratie a une influence déterminante, mais que la tradition légale n'est pas pertinente pour la productivité.