INFLATION, INFLATION VARIABILITY, AND CORRUPTION

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We present a model where agents can inflate the cost of goods needed to start an investment project and inflation variability increases monitoring costs. We show that inflation variability can lead to higher corruption and lower investment. We document a positive relationship between corruption and inflation variability in a sample of 75 countries. The effect is robust to the inclusion of country fixed effects, other controls, and 2SLS estimation. The results are economically significant: a one standard deviation increase in inflation variance from the median increases corruption by 12 percent of a standard deviation and reduces growth by 0.33 percentage points. Our paper highlights a new channel through which inflation reduces investment and growth, thus bridging the perception gap over the costs of inflation between economists and the public. We also find evidence that political competition reduces corruption and that corruption is pro-cyclical.

1. INTRODUCTION

CORRUPTION LEVELS vary greatly across countries. In 1995 a German exporter wanting to place an order in Zaire had to pay a bribe of up to 25 percent of the price of the good to the procurement officer. If the destination of the exports had been Namibia, the likely bribe demanded would have been 2 percent of the price. Even within developed nations there exist large differences in corruption. Whereas German exporters paid bribes of up to 15 percent of the price to place orders in Spain or Italy, the typical amount paid for destinations like Singapore or Belgium was zero.[1]

Why do we observe such differences? Our hypothesis is that they are partly due to problems in the transmission of information, such as difficulties in carrying out price comparisons. In a simple agency setting, these problems make it more costly for a principal to control an agent that has to report a price. They are also more severe when inflation varies and

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[1]The data come from a survey of German exporters carried out by Peter Neumann at *Impulse*, a German business publication. See, *Impulse*, Hamburg, Gruner + Jahr AG & Co., 1994.

relative prices oscillate.[2] In other words, high variability of inflation can make over-invoicing by procurement officers and under-invoicing by sales-persons easier because it makes auditing more expensive to the principal.

The modern literature on corruption started by Rose-Ackerman (1975, 1978) and Becker (1968) more than 20 years ago has offered a number of explanations for these differences. Three of these are deeply rooted in economics and can be referred to as control, market structure, and information. In the entry on *Bribes* in the *New Palgrave: A Dictionary of Economics*, Rose-Ackerman explained them succinctly:

> In short, if bribes are offered there must be some prospective excess profits out of which to pay them, and if bribes are accepted, it must be because the agent's superiors are either privy to the deal themselves or else cannot monitor the agent's behaviour adequately by such simple devices as comparing market prices with contract prices.
>
> (Rose-Ackerman, 1988, p. 278)

While some work has been done studying the role of market structure and of difficulties in providing proper incentives to agents (control) in causing corruption, little is known about the effects of information on the propensity to misrepresent prices. This paper seeks to fill this gap.

Theoretical studies on the relationship between market structure and corruption include Rose-Ackerman (1975, 1978), Shleifer and Vishny (1993), Bliss and Di Tella (1997), Choi and Thum (1999), Weinschelbaum (1999), Svensson (1999), Ades and Di Tella (1997, 1999), and Laffont and N'Guessan (1999). The last four studies also present evidence consistent with the hypothesis that rents and lack of competition generate corruption (see also Larraín and Tavares, 1999; Gatti, 1999; and Frechette, 2003). The papers by Becker and Stigler (1974), Mookherjee and Png (1989, 1995), Besley and McLaren (1993), and Andreoni et al. (1998), among others, develop the theory of how "control" can reduce corruption. We refer here to a class of models where the ability to keep bureaucrats under control depends on the auditing intensity and the combination of sticks (fines, dismissal) and carrots (wages, prestige, pensions) offered to the agent. Empirical work on these issues, however, is scant. Goel and Rich (1989) and

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[2]The overwhelming majority of corruption cases reported in the press involve misrepresentation of prices. Three famous examples are the case of Crawford Enterprises, the case of road building in Brazil, and that of Lambeth City Council, London. Crawford Enterprises Inc. pleaded guilty to paying $10 million in bribes to employees of Pemex, the Mexican oil company, in order to secure orders for oil and gas equipment at inflated prices (reported in *Wall Street Journal*, 1/7/83). Mr. Eliseo Resende, Minister of the Economy of Brazil in the 1990s, was found guilty of over-invoicing the construction of roads by amounts that ranged between 1,090 and 5,891 percent of the original price for the period 1967–1974 when he was head of the National Department of Roads (reported in *Le Monde*, 3/4/93). Lambeth City County officials, in the United Kingdom, were found to have paid 40 percent more on average for contracts for housing repair and road maintenance (reported in *The Times*, 1/23/93).

Van Rijckeghem and Weder (1997) provide estimates of the effect of wages on corruption (for micro evidence see Di Tella and Schargrodsky, 2003), while Treisman (1998) and Ades and Di Tella (1999) study the impact of democratic rights on the amount of corruption. Djankov et al. (2003), Brunetti and Weder (1999), and Besley and Pratt (2001) study the role of the media in reducing corruption. La Porta et al. (1999) find that countries with French or socialist legal systems and with a high proportion of Catholic or Muslim populations tend to have worse government performance. Their results are often interpreted as showing that these countries have worse monitoring by civil society of their governments. Some evidence on the role of fines in deterring corruption has been gathered by economists studying the effect of the American Foreign Corrupt Practices Act of 1977 (see, for example, Hines, 1996, and Wei, 1997). Finally, our paper is related to Gatti (1999) who shows that a uniform tariff structure can increase government revenue by limiting the amount of corruption amongst customs officials. She presents evidence consistent with the hypothesis that countries with a higher dispersion of trade tariffs have more corruption.

In this paper we present a simple model where agents can inflate the price that owners pay for goods that are needed to start an investment project. High and variable inflation is assumed to increase uncertainty about prices and therefore to increase the cost of auditing the agent's behavior. We then show how this can lead to higher corruption and lower investment in equilibrium. The main contribution of the paper, however, is empirical. We present evidence on the link between corruption and inflation variability in a sample of 75 countries over 14 years. Controlling for country fixed effects and variables that are used to proxy for other theoretically plausible influences on corruption, we find that higher inflation variability is associated with higher corruption. Furthermore, the effects are economically significant. Our basic panel estimates suggest that a one standard deviation increase in inflation variability from the median is associated with an increase in corruption of 12 percent of a standard deviation. The most significant aspect of these estimates is that, because we are able to include country dummies, they are not contaminated by the influence of time-invariant omitted variables. The literature has mentioned many such candidates, including culture, legal tradition, and ethnic composition, amongst many others. With very few exceptions, the corruption literature does not present fixed effects estimates, mainly because the corruption data vary very little over time and even univariate regressions show up insignificant coefficients once country dummies are included.

We tackle potential problems of simultaneity by using 2SLS estimates, although finding convincing instruments is a daunting task. We also show that the correlation between inflation and corruption is weaker (and statistically insignificant) than the correlation between corruption and inflation variability, something that can easily be accounted in our "information"

story where price changes cause corruption. We also find evidence bearing on the hypothesis that "control" helps reduce corruption: more political rights have a strong negative effect on corruption. The evidence also suggests that corruption is pro-cyclical.

Our results are directly related to the literature on the costs of inflation. Despite a long tradition of research on the subject, empirical estimates are scant. Following Bailey (1956) and estimating the area under the money demand curve, Fischer (1981) and Lucas (1981) found that for the US, an inflation rate of 10 percent per annum would cost 0.3–0.9 percent of national income each year. More recently, Fischer (1993) estimated in a cross-section of countries that an increase in the inflation rate of 100 percentage points would lead to a reduction in the annual growth rate of 3.9 percentage points. Furthermore, he found that the negative correlation between inflation and growth was stronger for low levels of inflation, and that inflation variance was also negatively correlated with growth. Barro (1997) estimated in a cross-section of countries that an increase in the average inflation rate of 10 percentage points per year leads to a reduction in the growth rate of GDP of 0.3 to 0.4 percentage points per year.

Although the size of these estimates is not negligible, they fail to capture the extent to which the general public seems to view inflation as a socially costly phenomenon. A recent paper by Robert Shiller (1996) highlights the differences in perception of inflation between professional economists and the general public by presenting survey evidence. In particular, Shiller shows that the public has concerns that inflation increases opportunities for deception and harms morality:

> The issues of inflation-generated opportunities for deception, and the effects of inflation on national cohesion and international prestige are curious for economists, and do not appear on the Fischer–Modigliani list. Perhaps it is here that we should listen carefully to what the public is telling us.
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> (Shiller, 1996, p. 40)

Our paper contributes to closing this perception gap. We find a theoretical and empirical link between inflation variability and corruption. Since corruption has been found to have a negative impact on growth and investment [Mauro (1995), Knack and Keefer (1995), Kaufmann and Wei (1999) inter alia], there is an indirect, corruption-induced cost of inflation.[3] We estimate that a one standard deviation increase in inflation variability from the median can lead to a reduction in the annual growth rate of one-third of a percentage point and a reduction in the investment rate of 1 percent.

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[3]See Mauro (1999) and Alesina and Weder (2002) for further work on the consequences of corruption.

In section 2 we present a basic principal–agent model isolating the conditions required to observe a positive association between higher inflation variability and corruption. In section 3 we present our empirical strategy and data. Section 4 presents our results while section 5 concludes.

2. THEORY

In this section we construct a simple model connecting inflation, corruption, and investment. The starting point is a modified version of the model of Holmstrom and Tirole (1996). In this model, entrepreneurs each have access to a technology by which, if they pay a fixed cost X, they obtain a return of z_1. Furthermore, for entry to occur, entrepreneurs must obtain a rent of at least z_c per project.[4] This implies that if the project is to be financed externally, investors can obtain a return of at most $z_0 = z_1 - z_c$.

Following Holmstrom and Tirole, we assume that $z_0 < X < z_1$. This means that the project is socially desirable, but it cannot be fully funded via external finance. Hence, the entrepreneur must have some initial wealth to start the project. In particular, the entrepreneur needs wealth of at least $W = X - z_0$. If we assume that W is strictly greater than the minimum of the support of the wealth distribution, then a proportion of potential entrepreneurs will be unable to finance projects. Furthermore, and most importantly, an increase in X, the fixed cost of starting the project, will lead to an increase in W, the wealth required to invest, and thus to a decline in the number of potential entrepreneurs actually able to invest. Hence, an increase in X will lead to a decline in aggregate investment.

Assume that the fixed cost X is the cost of a bundle of goods that the entrepreneur has to purchase over a period of time in order to set the project in motion. Assume further that it is costly for the entrepreneur to allocate time to purchasing these goods, and in general she will prefer to hire a specialized agent to buy them. The problem is that the agent may be tempted to over-invoice costs, and keep the difference between the reported price and the actual price.[5]

The agent buys the goods at a total cost of $p = \sum_{j=1}^m p_j q_j$, and reports to the principal (the entrepreneur), that his total costs were $\hat{p} \geq p$. Let $p \in [\underline{p}, \infty)$, and $p \sim G(p)$, where $G(p)$ is some probability distribution function derived from the individual distributions of prices of each good. $G(p)$ is commonly known by both the principal and the agent.

After the agent purchases the goods and reports a cost, the principal can choose to audit the accounts at a fixed cost c. If she chooses to audit and finds that the agent has over-invoiced costs, the principal receives the

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[4]Holmstrom and Tirole argue that moral hazard and limited liability lead to these rents.
[5]A typical situation is when the agent splits the surplus with a provider, who pays him a bribe in order to sell the product to the principal at an excessive price.

amount of over-invoicing back, and the agent suffers a non-pecuniary punishment of f.[6]

This implies that the cost to the principal, once $\hat{p}$ has been reported, is given by:

$$X|\hat{p} = \hat{p} - \alpha(\hat{p})[\hat{p} - E(p|\hat{p}) - c], \tag{1}$$

where $\alpha(\hat{p})$ is the probability of auditing given the reported cost, and $E(p|\hat{p})$ is the principal's belief of the expected value of the true cost given the reported cost.

Assuming that the principal cannot commit to an audit strategy, the equilibrium of this game will necessarily imply random auditing, except for very low reports.[7] If the principal is auditing with probability one for a certain value of the report, then the agent will only report this value if it is the true one. But then the principal would prefer not to audit, and thus this is not an equilibrium. On the other hand, if the principal is auditing with zero probability for a certain reported value, then the agent will report this value for any true value less than or equal to it, and keep the difference. Unless this value is very low, and the expected recovery is less than the cost of audit, then the principal will want to audit with probability one, proving that this is not an equilibrium either, and that auditing is necessarily random.

From the cost function above, it is clear that for random auditing it must be the case that

$$\hat{p} - E(p|\hat{p}) - c = 0. \tag{2}$$

That is, the expected recovery from auditing must be equal to the cost of auditing, making the principal indifferent between auditing or not, and thus willing to play a mixed strategy.

For illustrative purposes, we will restrict the agent's strategy space to strictly monotonic functions $\hat{p} = r(p)$, with $r'(p) > 0$ or $r'(p) < 0$ for all p.

This leads us to our first proposition, which says that the agent always over-invoices costs in the amount of the cost of audit, leaving the principal indifferent between auditing or not, and that the principal's audit probability is increasing in the cost reported.

Proposition 1. Assuming that the agent's strategy space is restricted to strictly monotonic functions $\hat{p} = r(p)$, the unique equilibrium of the audit

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[6]This non-pecuniary punishment, which can include jail time, loss of reputation, and thus loss of future employability, is usually bounded by the legal system. Otherwise, it could be set at infinity, and the incentive to over-invoice would disappear. See Becker (1968).

[7]See Reinganum and Wilde (1985), Khalil (1997), Andreoni et al. (1998), and Chatterjee and Morton (1999) for other models of auditing and a discussion of the problem of auditing without commitment.

game will be

  (i) $\hat{p} = p + c$ for all p.

  (ii) $\alpha(\hat{p}) = 1 - e^{-\frac{\hat{p}-p}{c+f}}$

Proof.

(i) In a sequential equilibrium of the game, the principal knows the actual value of over-invoicing, because $\hat{p} = r(p)$ is monotone, and therefore invertible. Hence, $E(p|\hat{p}) = r^{-1}(\hat{p})$ for all $\hat{p}$. This in turn implies that the ex-post cost to the principal is given by

$$X|\hat{p} = \hat{p} - \alpha(\hat{p})[\hat{p} - r^{-1}(\hat{p}) - c]. \tag{3}$$

Therefore, for the principal to audit randomly, we must have $\hat{p} - r^{-1}(\hat{p}) - c = 0$ which implies that $\hat{p} = p + c$ for all p. Thus, the agent always over-invoices in the amount of the cost of audit, leaving the principal indifferent between auditing or not.[8]

  (ii) For $\hat{p} = p + c$ to be an equilibrium reporting function, it must be true that it is the optimal function given the principal's audit strategy. Thus, we need

$$\hat{p} = p + c = \arg\max_{\hat{p}}[1 - \alpha(\hat{p})](\hat{p} - p) - \alpha(\hat{p})f, \tag{4}$$

where f is the non-pecuniary punishment suffered by the agent if he is found over-invoicing costs. The first-order condition for this problem implies that

$$\hat{p} = p - f + \frac{1 - \alpha(\hat{p})}{\alpha'(\hat{p})}.$$

Thus,

$$c = -f + \frac{1 - \alpha(\hat{p})}{\alpha'(\hat{p})}.$$

Imposing the boundary condition $\alpha(\underline{p}) = 0$,[9] the solution to this first-order differential equation is

$$\alpha(\hat{p}) = 1 - e^{-\frac{\hat{p}-p}{c+f}}. \tag{5}$$

$\square$

This means that the equilibrium audit probability is an increasing, concave function of the reported cost.

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[8]This of course depends on the assumption of a fixed cost of audit, and on limiting the agent's strategy space to strictly monotonic functions. However, Chatterjee and Morton (1999) find a similar equilibrium is the unique one to survive the D1 refinement in a more general framework.

[9]This boundary condition implies that if the agent reports the lowest price in the distribution of prices, then the principal audits with probability zero, because she is certain that no over-invoicing is taking place.

We focus on the impact of the cost of audit c on the equilibrium level of corruption and on the ex-ante expected fixed cost to the principal. Corruption Q is given by

$$Q = \hat{p} - p = c \quad \text{for all } p. \tag{6}$$

Hence, the expected value of corruption is simply $Q = c$.

The ex-ante expected fixed cost of the project is given by

$$X = E(p) + c. \tag{7}$$

Thus, an increase in the cost of audit leads to an increase in corruption and in the ex-ante fixed cost of investing.[10] This in turn leads to a decline in aggregate investment and growth. We assume that the cost of audit, c, is an increasing function of inflation variability, σ_π: $c = c(\sigma_\pi), c' > 0$.[11] This immediately leads to the result that high inflation variability leads to higher corruption and lower investment in equilibrium.

Notice that the model is quite general. It can equally be interpreted as referring to a public sector setting in which the principal is a government executive and the agent is a lower-level official. This application is important because the data on corruption that are available to test the model mainly refer to public sector corruption.

A final point to notice is that very high inflation variability can lead to the breakdown of the principal–agent relationship. Assume that the principal can purchase the goods directly in the market at a cost of $\tilde{X}$ (the higher cost includes the opportunity cost of her time). We have seen that the cost X of using the agent is an increasing function of inflation variability. It is plausible to imagine that for a certain level of inflation variability, $X > \tilde{X}$. This would lead the principal to purchase the goods directly and to end the relationship with the agent.[12] Our empirical results present suggestive evidence that this hypothesis is plausible.

3. DATA AND EMPIRICAL STRATEGY

In the next two sections we show that there is a positive partial correlation between inflation variability and corruption in a sample of 75 countries for

[10]One could possibly construct equilibria in which increases in the cost of audit lead to a lower level of corruption because the principal actually increases auditing to deter corruption. However, the costs X would still increase overall.

[11]The evidence on how relative price oscillations increase with inflation can be used to justify this assumption [however, fully developing this intuition would require, in turn, modeling how the increased price uncertainty gives the agent more discretion by changing the distribution of prices $G(p)$]. There is a large literature on price variability and inflation [see Cukierman (1983) for a survey]. Sheshinski and Weiss (1993) have a model of costly price adjustments where the (S, s) bands separate when inflation rises (see Proposition 1, p. 123). See also Vining and Elwertowski (1976), Cukierman (1979), Cukierman and Wachtel (1982), Lach and Tsiddon (1992), Tommasi (1996), Benabou and Gertner (1993), inter alia.

[12]Notice, however, that if $\tilde{X} > W + z_0$ then the project will become unfeasible before it becomes profitable for the principal to fire the agent.

which data are available. Furthermore, we argue that causality is from inflation variability to corruption. We follow an estimation strategy consistent with the theoretical discussion in the Introduction and in section 2. Our basic specification is of the following form:

$$CORRUPTION_{it} = \beta_1 INFORMATION_{it} + \beta_2 RENTS_{it}$$
$$+ \beta_3 CONTROL_{it} + \varepsilon_{it}, \tag{8}$$

where ε is an error term (assumed i.i.d.), and $CORRUPTION_{it}$ is the level of corruption in country i in year t. $INFORMATION$ is the ability of the principal to make price comparisons and is proxied by inflation variability, $RENTS$ refers to the level of rents in the economy that can be captured by bureaucrats who become corrupted, as proxied by imports over GDP, while $CONTROL$ refers to the amount of control that society has on government bureaucrats, as proxied by the degree of political rights in the country.

Our dependent variable, $CORRUPTION$, is the International Country Risk Guide (ICRG) corruption index introduced into economics by Knack and Keefer (1995). The data are yearly, and cover the period 1982–1994. The data indicate the opinion of analysts on each country regarding the extent to which "high government officials are likely to demand special payments" and "illegal payments are generally expected throughout lower levels of government" in the form of "bribes connected with import and export licences, exchange controls, tax assessment, policy protection or loans" (see Knack and Keefer, 1995, p. 225). Countries are scored from 0 to 6, where zero means higher corruption (we transformed the data to make our results easier to follow by subtracting the index from six, so that high values of the index mean a higher level of corruption).

Inflation variability, our proxy for $INFORMATION$, is defined as the log of the variance of monthly inflation per country-year. As in most studies involving inflation across countries, a decision concerning the role that will be given to exceptionally high inflationary episodes has to be made. These often introduce explosive dynamics and significant breaks in the data series. We follow the literature in trying to reduce the influence of these, relatively infrequent, episodes in our conclusions so as to try to derive implications that are more readily applicable to more usual circumstances.[13] The original data were obtained from the International Financial Statistics CD-ROM of the International Monetary Fund. We use the logarithm of imports as a percent of GDP to control for the existence of rents ($RENTS$, from the Penn World Tables), and the Gastil index of political rights as a proxy for the

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[13]In using the log specification we follow Fischer (1993), who finds non-linear effects of inflation on growth, and shows that the log specification is a better fit for the data. Using the non-logged data increases substantially the influence of high inflation outliers (see robustness checks below).

TABLE 1A   SUMMARY STATISTICS

Variable	Cross-section					Panel (mean = 0)			
	Obs.	Mean	S.D.	Min.	Max.	Obs.	S.D.	Min.	Max.
Corruption	75	2.51	1.47	0	5.43	841	0.49	−1.77	1.88
Inflation Variance	75	2.57	1.89	−0.65	9.03	841	0.97	−3.84	4.45
GDP per Capita	75	8.13	1.03	5.74	9.72	841	0.10	−0.33	0.46
Political Rights	75	0.61	0.32	0.01	1.00	841	0.18	−1.68	0.76
Imports/GDP	75	3.40	0.59	1.90	5.22	841	0.75	−3.33	3.13
Inflation	73	−2.29	1.04	−4.00	1.54	841	0.78	−5.27	3.07

TABLE 1B   CORRELATION COEFFICIENTS
Cross-section regressions

	Corruption	Inflation Variance	GDP per Capita	Political Rights	Imports/GDP
Corruption	1				
Inflation Variance	0.54	1			
GDP per Capita	−0.70	−0.58	1		
Political Rights	−0.59	−0.55	0.75	1	
Imports/GDP	−0.18	−0.28	0.21	0.12	1
Inflation	0.34	0.70	−0.22	−0.12	−0.47

Panel regressions

	Corruption	Inflation Variance	GDP per Capita	Political Rights	Imports/GDP
Corruption	1				
Inflation Variance	0.46	1			
GDP per Capita	−0.67	−0.60	1		
Political Rights	−0.54	−0.46	0.68	1	
Imports/GDP	−0.13	−0.19	0.13	−0.03	1
Inflation	0.13	0.49	−0.16	−0.02	−0.28

intensity of political competition in the country [*CONTROL*, from Freedom House, Gastil (various issues)]. Finally, we included the log of GDP per capita as a control for other omitted variables that might jointly affect corruption and inflation variability. Thus, the specification is similar to the corruption regressions presented in Ades and Di Tella (1999). The maximum sample is of 75 countries,[14] and is listed in Appendix B. Our other controls are standard in cross-country regressions, and are described in more detail in Appendix A. Tables 1a and 1b present summary statistics and simple correlations, while in Figure 1 we plot the log of inflation variability on the ICRG corruption index. In Figure 2 we show the behavior of average corruption and log inflation variability.

[14]The 75 countries in the sample are those for which complete data on monthly inflation exist, and are included in the ICRG dataset.
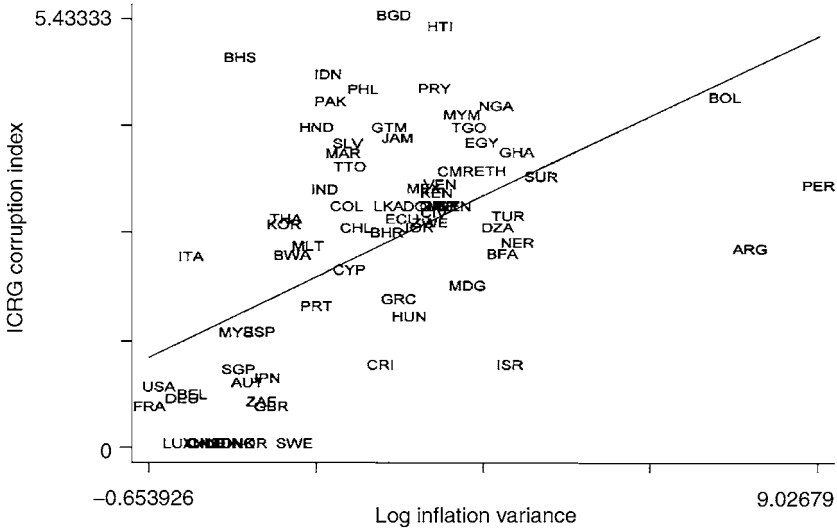
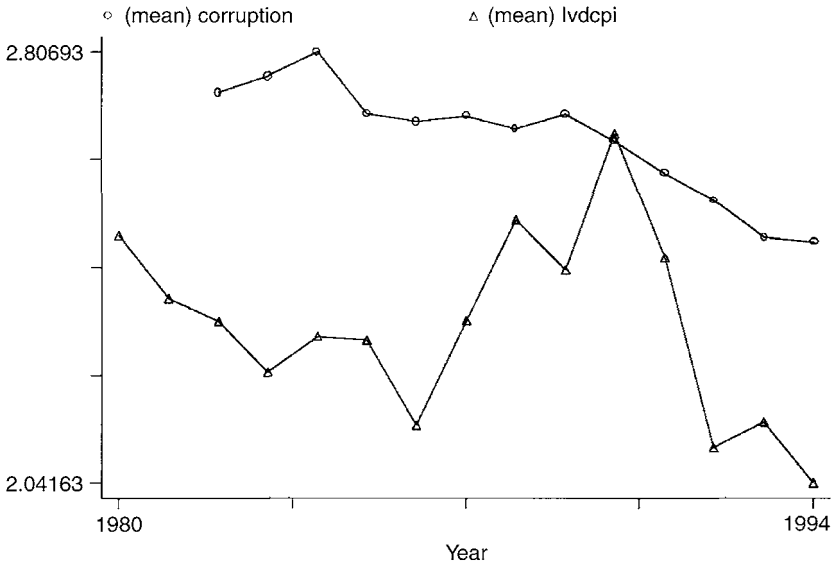Figure 1. Scatterplot of corruption on inflation variance.

Figure 2. Yearly averages of corruption (○) and log inflation variance (△).

4. RESULTS

In Table 2a, we present cross-section estimates of the correlation between inflation variability and corruption. We average the data for 1982–1994 to

TABLE 2A   CORRUPTION REGRESSION, 1982–1995, CROSS-SECTION

Variable	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) OLS	(7) OLS
Inflation Variance	0.423**	0.627**	0.239**	1.061**	0.771		0.555**
	(0.090)	(0.076)	(0.108)	(0.213)	(0.521)		(0.084)
GDP per Capita			−0.655**		−0.408		
			(0.172)		(0.430)		
Imports/GDP			−0.039		0.209		
			(0.156)		(0.410)		
Political Rights			−0.350		0.313		
			(0.510)		(1.180)		
Inflation						0.721**	0.217
						(0.162)	(0.138)
Hyperinflation		−2.851**	−0.841	−5.623**	−3.874	−1.921**	−3.152**
Dummy		(0.554)	(0.648)	(1.500)	(2.720)	(0.849)	(0.665)
Constant	1.420**	1.047**	7.604**	0.219	3.236	4.265**	1.742**
	(0.274)	(0.244)	(1.687)	(0.369)	(6.022)	(0.389)	(0.498)
No. Observations	75	75	75	50	50	73	73
Adj. R^2	0.29	0.42	0.53	0.28	0.47	0.17	0.40

Notes: Dependent Variable: ICRG Corruption Index (Average 1982–1994). Regressions (4) and (5) use *Central Bank 1* and *Central Bank 2* as instruments, *denotes 10% significance; **denotes 5% significance. Heteroskedasticity-corrected standard errors in parentheses in columns (1)–(5). Variables are described in detail in Appendix A.

obtain a maximum sample. In column (1) we document a positive and significant correlation between our measure of noise in the price system (*Inflation Variance*) and corruption. Inspection of the raw data, however, suggests there exist a number of outliers and that these are the countries that have suffered hyperinflationary episodes during our sample period. As suggested in the theory section, in very uncertain environments principal–agent contracts may be less prevalent, leading to fewer corruption opportunities. Regression (2) includes a dummy for hyperinflation countries and finds a somewhat stronger correlation between inflation variability and corruption.[15] Furthermore, the coefficient on the hyperinflation dummy is negative and significantly different to zero. This provides some support to the hypothesis that very high inflation variability can lead to the breakdown of principal–agent relationships, and thus lead to lower corruption.

Regression (3) shows that this correlation is robust to the inclusion of a control for the level of development (log GDP per capita) and controls aimed at capturing the other two explanations for corruption: market structure and control. As a control for market structure, we use the log of imports as a percent of GDP in the hope of capturing the influence of

[15]We defined a hyperinflationary country as a country that suffered a year of inflation greater than or equal to 384 percent, the inflation rate of Israel in 1984. The countries in our sample that met this criterion are Argentina, Bolivia, Israel, and Peru.

foreign competition on domestic firms. We include the Gastil index of political rights as a proxy for the intensity of political competition and the level of monitoring by civil society.[16] Again, the association between corruption and inflation variability is significant both in statistical and economic terms. A one standard deviation increase in the variance of inflation from the median is associated with an increase in the corruption index equal to 32 percent of a standard deviation in that index.[17] In terms of standardized coefficients it is the second largest and almost 67 percent of the estimate on *GDP per capita* [the largest standardized coefficient in regression (3)].[18]

A potential criticism to these results is that they may be capturing a reverse causal relationship. It is indeed possible that countries where the bureaucracy is corrupt have lower tax receipts. These countries may also be more prone to print money rather than borrow, increase taxes or reduce spending accordingly. Although our focus is inflation variability and not inflation, we address this issue in regressions (4) and (5) by instrumenting *Inflation Variance* with two measures of central bank independence produced by Cukierman et al. (1992) and described in the Appendix. Our identifying assumptions are that the central bank independence variables affect corruption only through *Inflation Variance*. Although the instrument is plausible from an economic point of view, the sample falls to 50

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[16]We also experimented with other variables as controls for rents, such as exports plus imports as a percent of GDP, the foreign exchange black market premium, and fuel and mineral exports as a percent of merchandise exports, with no significant changes in the results. The same is true if we include other measures of control, such as the Gastil index of civil liberties, the extent of revolutions and coups, the years of schooling of population over age 25 and an index of judicial effectiveness from *Business International*. The results also survive the inclusion of more than one of these variables at the same time, although the theoretical justification for such an approach is weaker. Results are available upon request.

[17]Owing to the log specification used for inflation variability, the derivative of corruption with respect to inflation variability is decreasing in inflation variability. In fact, it is determined by

$$\partial CORRUPTION / \partial INFLATION\ VARIANCE = (1/INFLATION\ VARIANCE)\beta,$$

where β is the coefficient on inflation variability. The median of inflation variability is 15.68 in our sample. Therefore, the derivative of corruption with respect to inflation variability at the median is 0.239/15.68. If we multiply this number by the standard deviation of inflation variability (excluding hyperinflation countries) which is 31.07, we obtain 0.47, which is the amount by which corruption increases in response to an increase of one standard deviation in inflation variability. The standard deviation of corruption in our sample (excluding hyperinflation countries) is 1.485. Therefore, this implies that an increase in inflation variability of one standard deviation leads to an increase in corruption of 0.32 standard deviations.

[18]A number of authors have emphasized the role of culture [see, for example, La Porta et al. (1999) and Treisman (1998)]. The coefficient on *Inflation Variance* was still comfortably significant in simple specifications that included dummies for the legal origin of the country or dummies for the main religion. The coefficient on *Inflation Variance* was significant at the 7 percent level, however, if we included all the controls in regression (3), plus the five dummies for legal origin and six dummies for main religion in the country. Our main results were also unaffected when we included regional dummies. Results are available upon request.

TABLE 2B   PARTIAL EFFECT OF INFLATION VARIABILITY ON OTHER CORRUPTION INDICATORS

	Table 2a regression	
Dependent variable $= X$	(2)	(3)
$X =$ World Bank Corruption Index ($n = 77$)	−0.475**	−0.203**
	(0.043)	(0.065)
$X =$ Transparency International Index ($n = 57$)	−1.184**	−0.291
	(0.142)	(0.197)
$X =$ World Competitiveness Yearbook Corruption Index ($n = 34$)	−1.333**	−0.516*
	(0.227)	(0.303)

Notes: Columns (2) and (3) in Table 2a report the estimated coefficient on *Inflation Variability* in regressions with the same specification as regressions (2) and (3) in Table 2a respectively, but using the indicated corruption index as dependent variable. *n* denotes the sample size, which varies due to data availability. *denotes 10% significance; **denotes 5% significance. Heteroskedasticity-corrected standard errors in parentheses in columns (1)–(5).

Note that because of the way in which these alternative corruption indices are defined, a negative coefficient means that measured corruption is positively correlated with *Inflation Variability*. Variables are described in detail in Appendix A.

countries.[19] The coefficients on *Inflation Variance* are both positive and somewhat larger than the OLS counterparts, though only significant in regression (4) [in regression (5) the coefficient is only significant at the 15 percent level]. Regressions (6) and (7) present suggestive evidence that we are not capturing reverse causality. They exploit the fact that in order to study the role of information in determining corruption we focus on the variability of inflation, not on the level of inflation. Regression (7) shows that *Inflation Variance* is a better predictor of corruption than *Inflation*. In fact the coefficient on the latter ceases to be significant once *Inflation Variance* is included. In order to argue that reverse causality is driving the association in regression (2), one would have to argue that corruption affects inflation variability *more* than inflation, a condition that seems implausible.

To check the robustness of our results, we repeat our baseline regressions (2) and (3) of Table 2a, with widely used alternative measures of corruption. We use the World Bank "control of corruption" index constructed by Kaufmann et al. (1999, 2002), the index constructed by Transparency International, and the index from the *World Competitiveness Yearbook* compiled by the Institute for Management Development in Geneva. In Table 2b we report the coefficients on log of inflation variability, and find that results are robust.

[19]Although there is an issue with the power of these tests, we checked our assumptions using Hausman's test of over-identifying restrictions, and could not reject the exogeneity of the instruments at conventional levels. The residuals from the second-stage regression of 2SLS in column (5), Table 2a, are regressed on all the exogenous variables in the system. The test statistic for the validity of the over-identifying restrictions is constructed as $n * R^2$, where *n* is the number of observations and R^2 is the unadjusted R^2 from the residual regression. This test statistic has a chi-squared distribution with one degree of freedom (number of instruments minus number of endogenous regressors). The exogeneity of the over-identifying restrictions cannot be rejected at conventional levels (p-value > 0.25).

Given the weight of high inflation episodes, we further checked the robustness of our results to outliers by dropping one country at a time from our baseline regressions. In addition, we experimented with different definitions of high inflation episodes,[20] and with a quadratic functional form. The results were consistent with our findings in Tables 2a and 2b.[21]

As is often the case with cross-section regressions, it could still be argued that the correlation might be driven by some time-invariant omitted variables. This would be the case with other cultural influences (that were not captured by the dummies for legal origin and religion), colonial history, constitutional tradition, or other institutional arrangements. We therefore exploit the time dimension of the ICRG corruption data, and present results for regressions controlling for country fixed effects in Tables 3 and 4. It is worth mentioning that, by and large, the ICRG corruption data vary more across countries than over time in our sample. This is due to the fact that corruption is difficult to measure, and changes over time within countries may be more difficult to detect than differences across countries. As a measure of this, note that less than 19 percent of the total variation in the corruption data is accounted by the within variation. The same is true with other corruption datasets. Accordingly, previous research has largely focused on cross-section studies (when fixed effects estimators are presented, they are marginally significant).

In Table 3 we present regressions using yearly data. Regression (1) finds a positive and insignificant (significant at the 14 percent level) association between corruption and *Inflation Variance*. Again a number of outliers are hyperinflationary episodes. When these are excluded in regression (2) the correlation is positive and well-defined. However, the size of the coefficient is smaller than the cross-section estimates. Now a one standard deviation increase from the median in *Inflation Variance* is associated with an increase of 16 percent of a standard deviation in corruption.[22] In regression (3) we

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[20]We defined high inflation periods as (i) countries with average inflation above 50%; (ii) countries with inflation episodes higher than 100%; and (iii) countries with inflation episodes higher than 200%.

[21]In regression (2), the coefficients (s.e.) on *Inflation Variance* and *Inflation Variance* squared were 0.0015 (0.0006) and $-1.49e-07$ (7.41e-08), meaning that the coefficient becomes smaller for higher values of *Inflation Variance*. Full results are available upon request.

[22]The derivative of corruption with respect to inflation variability is determined by

$$\partial CORRUPTION / \partial INFLATION\ VARIANCE = (1/INFLATION\ VARIANCE)\beta,$$

where β is the coefficient on inflation variability (see footnote 15). The median of inflation variability is 6.80 in our panel sample. Therefore, the derivative of corruption with respect to inflation variability at the median is 0.050/6.80. If we multiply this number by the standard deviation of inflation variability (excluding hyperinflation countries) which is 35.56, we obtain 0.26, which is the amount by which corruption increases in response to an increase of one standard deviation in inflation variability from the median. The standard deviation of corruption in our panel sample (excluding hyperinflation countries) is 1.59. Therefore, this implies that an increase in inflation variability of one standard deviation leads to an increase in corruption of 0.16 standard deviations.

TABLE 3   CORRUPTION REGRESSIONS, 1982–1994, YEARLY DATA, FIXED EFFECTS

Variable	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) OLS	(7) OLS
Inflation Variance	0.022 (0.014)	0.050** (0.017)	0.037** (0.019)	0.079 (0.050)	0.106* (0.066)		0.047** (0.019)
GDP per Capita			0.729** (0.248)		0.791** (0.266)		
Imports/GDP			−0.104 (0.152)		−0.092 (0.154)		
Political Rights			−0.080** (0.027)		−0.080** (0.029)		
Inflation						0.033 (0.024)	0.006 (0.025)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hyperinflation Episodes	Yes	No	No	No	No	No	No
No. Observations	1,125	1,061	841	1,030	815	997	997
Adj. R^2	0.88	0.88	0.92	0.89	0.92	0.89	0.89

Notes: Dependent Variable: ICRG Corruption Index (Yearly). Columns 4 and 5 use one- and two-year lagged inflation variance as instruments. *denotes 10% significance; **denotes 5% significance. Heteroskedasticity-corrected standard errors in parentheses. Variables are described in detail in Appendix A.

TABLE 4   CORRUPTION REGRESSIONS, 1980–1994, FIVE-YEAR AVERAGES, FIXED EFFECTS

Variable	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Inflation Variance	0.003 (0.047)	0.106** (0.050)	0.094** (0.047)		0.151** (0.064)
GDP per Capita			0.657 (0.522)		
Imports/GDP			−0.284 (0.299)		
Political Rights			−0.072 (0.056)		
Inflation				0.028 (0.060)	−0.076 (0.067)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Hyperinflation Episodes	Yes	No	No	No	No
No. Observations	267	250	241	243	243
R^2	0.92	0.92	0.93	0.92	0.92

Notes: Dependent Variable: ICRG Corruption Index (Five-year average). *denotes 10% significance and **denotes 5% significance. Heteroskedasticity-corrected standard errors in parentheses. Variables are described in detail in Appendix A.

include *GDP, per Capita*, *Imports over GDP* and *Political Rights* as controls. Perhaps surprisingly, we find that GDP per capita is positively correlated with corruption in the panel regressions (although it is negatively related in the cross-section). This is consistent with corruption having a pro-cyclical nature.[23] A number of authors have emphasized that ''moral standards'' are lowered during booms, as greed becomes the dominant force for economic decisions (e.g. Kindleberger, 2000). Although developing such behavioral stories is beyond the scope of this paper, we note that the evidence is consistent with the informal accounts we have available of behavior during times of economic euphoria. We also find that openness to trade as measured by imports as a percent of GDP is negatively (although not significantly) correlated with corruption and that higher political rights are strongly negatively related with corruption. This is consistent with the idea that monitoring by civil society reduces the incidence of corruption. A one standard deviation increase in *Political Rights* is associated with a decrease of 10 percent of a standard deviation in the corruption index. This stands in contrast with the findings of Ades and Di Tella (1999) and Treisman (1998) who fail to find beneficial effects of political competition on corruption. Lastly, the coefficient on *Inflation Variance* is positive, significant, and 26 percent smaller in size than the one presented in regression (2). If the effects are taken to be causal, a one standard deviation increase in *Inflation Variance* leads to an increase of 12 percent of a standard deviation in the corruption index.

Regressions (4) and (5) address concerns of simultaneity by using one- and two-year lags in *Inflation Variance*. The estimated coefficients on *Inflation Variance* are positive, larger, and less well-defined than the OLS estimates (significant only at the 12 percent and 10 percent levels respectively). Regressions (6) and (7) show that corruption is more strongly correlated with *Inflation Variance* than with *Inflation*. Again, this implies that if corruption were causing inflation, we would need to produce a theory in which corruption affects the variance but *not* the level of inflation.

In Table 4 we repeat the regressions of Table 3 where possible, but using five-year averages for the data. This smooths out some of the possible measurement problems in the yearly data but at the same time retains a time dimension. Estimates using these three periods largely obtain similar results.

We conducted robustness checks for our panel regressions by repeating estimations while dropping one country at a time, including a time trend, and trying alternative cutoffs for high inflation (100 percent and 200 percent). Results were, in general, robust. However, when a time trend was included in the regressions, the coefficient on inflation variability falls in size

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[23]This is in contrast to Ades and Di Tella (1999), who present conflicting evidence on this issue using shorter panels. More recently, Frechette (2003) also finds evidence consistent with the Kindleberger hypothesis.

and significance in our base specifications (2) and (3) of Table 3. This might reflect the fact that part of the relation between inflation variability and corruption is possibly driven by time-varying factors such as improved macroeconomic management and public sector reform.

5.   INFLATION VARIABILITY, INVESTMENT, AND GROWTH

The literature on the costs of inflation that we briefly reviewed in the Introduction has found a small but not insignificant impact of inflation on growth. However, there still remains a gap in the perception of the costs of inflation between professional economists and the general public, documented in Shiller (1996). Among other costs, the public seems to believe that inflation tends to generate opportunities for deception and reduce morality in society. In our model, we showed how inflation variability can lead to a reduction in investment and growth via an increase in corruption, and that this can help close the perception gap. We now attempt to quantify this channel.

Our estimates may be used to derive an indirect, corruption-induced, cost of inflation variability. This cost can be calculated by multiplying our estimates of the impact of inflation variability on corruption by exogenous estimates of the impact of corruption on investment and growth. Given that Mauro (1995) presents such estimates, this calculation is relatively straightforward.

Using an index of ethnolinguistic fractionalization as an instrument for corruption, Mauro estimates that an increase in corruption of one standard deviation leads to a decline in the average investment rate of 8.5 percent of GDP. He also estimates that GDP growth would decline by 2.76 percentage points per year.

In section 4 we calculated that our cross-section estimate in column (3) of Table 2a implies that an increase in inflation variability of one standard deviation from the median leads to an increase in corruption of 0.32 of a standard deviation. Combining our estimate with Mauro's, the result is that an increase in inflation variance of one standard deviation leads to a decline in investment of 2.72 percent of GDP, and a decline in growth of 0.88 percentage points.

We also calculated that using our panel estimate of column (3), Table 3, an increase in inflation variability of one standard deviation from the median leads to an increase in corruption of 0.12 of a standard deviation. Repeating the above calculations we obtain that an increase in inflation variance of one standard deviation leads to a decline in investment of 1.02 of GDP, and a decline in growth of 0.33 percentage points. Therefore, our estimates for the impact of an increase in inflation variability of one standard deviation range from 1.02 to 2.72 percent of GDP for investment, and from 0.33 to 0.88 percentage points for growth.

These estimates are, of course, rather crude but they give an approximate figure for the magnitude of the impact of inflation variability on investment and growth via the corruption channel.

6. CONCLUSIONS

The general public is concerned about the impact of inflation on morality and opportunities for deception (see the survey evidence presented in Shiller, 1996). These costs of inflation have not been incorporated into mainstream economics. Yet, in a simple model of auditing, any informational problems caused by inflation can lead to more corruption in equilibrium. Although some empirical work on the causes and consequences of corruption has been done following the introduction of the first cross-country corruption database by Mauro (1995), this hypothesis has remained largely untested. Furthermore, corruption has been noted to reduce investment and growth, so there could be a link between growth and factors that affect uncertainty about prices, such as the level and variability of inflation, through a corruption channel. This paper seeks to contribute to the understanding of the costs of inflation by studying its relationship to corruption.

We first develop a simple principal–agent model of investment and auditing to introduce the main theoretical issues. Owners can run their firms or hire an agent to do so. The root assumption is that more inflation variability increases the cost of auditing the agent's behavior due to information problems. Our model shows how higher inflation variance can lead to more corruption in equilibrium. Furthermore, higher inflation variability increases the cost of investment due to corruption. In our model, this translates into a lower equilibrium number of entrepreneurs being able to invest, and therefore to lower aggregate investment. To the extent that lower investment leads to lower growth, this is a channel through which inflation variability hurts growth.

The empirical evidence suggests that the amount of corruption in a country is positively correlated with the variance of inflation. The correlation is robust to the inclusion of variables that are used to proxy for other theoretically plausible influences on corruption. Furthermore, and in contrast to most previous work in the literature, the correlation survives the inclusion of country fixed effects in panel regressions, a remarkable fact given the small amount of within-country variation present in the data. Given the difficulty of finding a convincing instrument, particularly for the panel regressions, we have to leave a full investigation of causality for future work. However, we provide some evidence of the existence of a causal link by presenting 2SLS estimates using indices of central bank independence as instruments in the cross-section, and by showing that inflation variability is a better predictor of corruption than inflation. This last finding is unlikely in a world where corruption causes changes in inflation. In contrast to the

previous literature, we find strong evidence in favor of the hypothesis that political competition reduces corruption and for the hypothesis that corruption is pro-cyclical. This last result echoes the informal accounts in Kindleberger (2000) describing how greed rises during times of economic euphoria.

The estimated effects are also economically significant. Our basic cross-section estimate suggests that a one standard deviation increase in the variance of inflation is associated with an increase in corruption of up to 0.47 points, or 32 percent of the standard deviation of corruption. These estimates can be used to calculate an indirect cost of variable inflation that operates through corruption. We find that an increase in inflation variability of one standard deviation from the median can lead to a decline in investment of 2.7 percent of GDP, and to a decline in the annual growth rate of 0.9 percentage points. The panel estimates suggest that a one standard deviation increase in inflation variability would increase corruption by 12 percent of a standard deviation, and that this would imply a 1 percent drop in the investment rate and a decline in the annual growth rate of one-third of a percentage point.

APPENDIX A.   DESCRIPTION OF VARIABLES

Corruption: International Country Risk Guide corruption index. The range is 0 to 6, where 6 indicates a higher incidence of corruption. (In its original form, higher values of the index implied less corruption, but we transformed the variable by subtracting it from 6.) The data indicate the opinion of analysts on each country regarding the extent to which "high government officials are likely to demand special payments" and "illegal payments are generally expected throughout lower levels of government" in the form of "bribes connected with import and export licences, exchange controls, tax assessment, policy protection or loans" (Knack and Keefer, 1995).

Alternative corruption measures:

- Transparency International Index: compiled by the NGO Transparency International, based on a survey of polls in different countries. Ranges from 1 (highest) to 10 (lowest) corruption. For methodology, see www.transparency.org
- World Bank Index: control of corruption index compiled by the World Bank. Data range from –2.5 to 2.5 with higher values indicating lower corruption. Source: Kaufmann et al. (1999, 2002).
- World Competitiveness Yearbook Index: corruption index from the *World Competitiveness Yearbook* compiled by the Institute for Management Development in Geneva. Measures the "extent of improper practices such as bribing and corruption." See http://www01.imd.ch/wcy/methodology/ for methodology.

Inflation Variance: Log of variance of monthly inflation for each country-year. Source: International Financial Statistics (IFS), IMF.

Imports/GDP: Log of imports over GDP. Source: Penn World Tables, Mark 5.6. See Summers and Heston (1991).

Political Rights: Gastil index of political rights. Ranges from 0 to 1, where higher values represent more political rights. The original data range from 0 to 7, and comprise a subjective index compiled by Raymond Gastil and his followers. It annually ranks countries in seven categories according to a checklist of political rights, including the existence of fair electoral laws, equal campaigning opportunities, and fair polling. Source: Gastil (various issues).

Hyperinflation Dummy: Countries that suffered yearly inflation higher than 384 percent (Israel 1984).

Inflation: Log of annual change in consumer price index. Source: IFS and IMF.

Central Bank 1: Legal Central Bank Independence Index. Ranges from 0 to 1, where higher values represent more independence. Constructed by averaging indices, taken mostly from written rules such as central bank charters, on 16 variables related to four areas of central bank practice: (1) the appointment, dismissal, and term of office of the chief executive officer; (2) the policy formulation cluster (resolution of conflicts between the central bank and the executive; (3) the objectives of the central bank; (4) limitations on the ability of the central bank to lend to the public sector. Source: Cukierman et al. (1992).

Central Bank 2: Overall Central Bank Independence Index. Ranges from 0 to 1, where higher values represent more independence. Constructed as a weighted average of legal central bank independence and the rate of turnover of central bank governors. Source: Cukierman et al. (1992).

APPENDIX B.   LIST OF COUNTRIES

Algeria, Argentina, Austria, Bahamas, Bahrain, Bangladesh, Belgium, Bolivia, Botswana, Burkina Faso, Cameroon, Canada, Chile, Colombia, Costa Rica, Côte d'Ivoire, Cyprus, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Finland, France, Gambia, Germany, Ghana, Greece, Guatemala, Haiti, Honduras, Hungary, India, Indonesia, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea (South), Luxembourg, Madagascar, Malaysia, Malta, Mexico, Morocco, Myanmar, Netherlands, Niger, Nigeria,

Norway, Pakistan, Paraguay, Peru, Philippines, Portugal, Senegal, Singapore, South Africa, Spain, Sri Lanka, Suriname, Sweden, Switzerland, Thailand, Togo, Trinidad and Tobago, Turkey, United Kingdom, USA, Uruguay, Venezuela, Zimbabwe.

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