FONDATION POUR LES ÉTUDES ET RECHERCHES SUR LE DÉVELOPPEMENT INTERNATIONAL

Working Paper 49 July 2012 Development Policies

When Corruption is a Response to Export Instability

April 2013 Update

Joël Cariolle

Joël Cariolle, Phd Candidate, is a Research Assistant for Ferdi on vulnerability issues since 2008. He is also a consultant on anticorruption issues.
E-mail : cariolle.joel@gmail.com

Abstract

This paper is an empirical study on the effects of export instability on corruption, in developed and developing countries. We consider that corrupt transactions may arise from the necessity to protect against the detrimental effects of income fluctuations on welfare. We assume that export instability may have ex post and ex ante effects on corruption, resulting from agent's experience and perception of export fluctuations, respectively. We conduct empirical estimations of these effects using measures of volatility based on the standard deviation and the skewness of the distribution of exports around their trend. On the one hand, fixed effect, instrumental variable (IV) and system-Generalized Method of Moments estimations are conducted on a panel of 68 developed and developing countries covering the period 1985-2005, using data on corruption perceptions taken from the International Country Risk Guide. On the other hand, we run comparable Ordinary Least Square and IV cross-section estimations on a sample of more than 9000 firms clustered in 23 developing countries, using data on bribes paid by firms drawn from the World Bank Enterprise Surveys. …/…

JEL classification: D10, O11, O12, O17

Acknowledgements
I would like to thank Patrick Guillaumont, Michaël Goujon, Vianney Dequiedt, Jean-louis Combes, Bernard Gauthier, Laurent Wagner and Gaëlle Balineau for helpful comments and suggestions. Remaining errors are mine.

LA FERDI EST UNE FONDATION RECONNUE D'UTILITÉ PUBLIQUE.
ELLE MET EN ŒUVRE AVEC L'IDDRI L'INITIATIVE POUR LE DÉVELOPPEMENT ET LA GOUVERNANCE MONDIALE (IDGM).
ELLE COORDONNE LE LABEX IDGM+ QUI L'ASSOCIE AU CERDI ET À L'IDDRI. CETTE PUBLICATION A BÉNÉFICIÉ D'UNE AIDE DE L'ÉTAT FRANCAIS
GÉRÉE PAR L'ANR AU TITRE DU PROGRAMME « INVESTISSEMENTS D'AVENIR » PORTANT LA RÉFÉRENCE « ANR-10-LABX-14-01 »

… /… We find evidence of robust, significant and nonlinear *ex post* and *ex ante* effects of instability on corruption, depending on the frequency and size of export fluctuations. We show that the liquidity constraint is a key channel for these effects: when the liquidity constraint hardens, instability is found to foster corruption; while when it softens, instability is found to reduce it. Thus, corrupt strategies may act as a substitute for financial market imperfections and a low state capacity for mitigating the consequences of economic fluctuations on welfare.

1. Introduction

As the columnist Eduardo Porter pointed out in the New York Times, if trust in institutions and perceptions of good governance are probably better off during good times than during hard times (Stevenson and Volfers, 2011; Kaplan and Panthania, 2010), there is in parallel a high temptation for fraud, embezzlement and other corruption offences during "the general prosperity of economic booms". His view strongly coincides with a former work of Galbraith (1997), who stresses that economic crises are often followed by scandals of large-scale corruption, revealing the prevalence of malpractices in the administration of public and private affairs prior to economic reversal. The 2008 worldwide financial crisis and its consequences on national public accounts and fiscal solvency are striking illustrations of this complex link between public and private sector governance and output fluctuations. While poor norms of transparency and lack of accountability mechanisms in the management of public and private funds contributed to the dramatic economic collapse experienced by industrialized economies, these malpractices found a fertile ground in the recklessness and opulence of economic and financial expansion.

The relationship between governance quality and output fluctuations has already been emphasised by the economic literature. On the one hand, the contribution of bad governance to the instability of output is evidenced in important cross-country analyses (Acemoglu et al. (2003) or Mobarak (2005)). On the other hand, it has been shown that the ability of governments to handle economic crisis depends on the quality of institutions (Rodrik (2000); Arin et al. (2011)). Rodrik (2000) shows that democratic institutions foster political consensus around policy responses to external shocks, while Arin et al. (2011) find that corrupt OECD countries are less likely to rebalance their budget during serious attempts of fiscal consolidation. Thus, according to these studies and in the light of the recent economic events, the contour of a vicious circle between bad governance and the instability of output looms: economic shocks are more likely to occur, and their destabilizing effects are more likely to persist, where institutions fostering good public and private governance are weaker.

The missing (or under-documented) element of this puzzling equation is the reverse causality, namely, the impact of output fluctuations on institutions and governance quality. The consequences of economic fluctuations on institutional variables have been so far studied by very few contemporaneous empirical studies. Brückner and Ciccone (2011) find a positive effect of adverse shocks on the quality of institutions, arguing that citizens are likely to voice their discontent and hasten democratic change during hardships. By contrast, others advance that transient economic booms may foster illegal enrichment of agents in charge of public affairs in 29 African countries (Voors et al., 2011), and 39 developed and emerging countries (Gokcekus and Suzuki, 2011). Building on these recent contributions, we provide additional insights into the effects of economic instability on corruption, at both macro and micro levels. While taking into account the pro-cyclical relationship between transient output movements and corruption stressed by Voors et al. (2011) and Gokcekus and Suzuki (2011), we advance that corrupt transactions may also arise from the necessity to protect against the detrimental effects of income fluctuations on welfare. In other words, corruption may represent a response to risk, together with the usual risk-coping and risk-management strategies emphasised by analyses of households saving and insurance decisions (Dercon, 2002; Elbers et al. 2007).

Along this paper, we focus on corrupt transactions involving both public and private agents, considering corruption as "the abuse of entrusted power for private gain" (Transparency International, 2009, p.24). We place the emphasis on the instability in the constant value of export earnings, since exports are a major mostly-external source of output fluctuations, with strong destabilizing effects on growth, tax, and redistribution policy (Guillaumont 2010, 2009ab; Jones and Olken, 2010; Easterly et al., 1993; Bevan et al., 1993).

Building on researches made by Dercon (2002), and Elbers et al. (2007), we assume that export instability has *ex ante* and *ex post* effects on corruption, resulting from agents' perception and experience of economic instability. We identify the *ex ante* and *ex post* effects of instability using measures of instability based on the standard deviation and the skewness of the distribution of exports around their trend, respectively. *Ex ante* and *ex post* effects of instability are tested on measures reflecting corruption prevalence at macro and micro-levels. On the one hand, fixed effect (FE), instrumental variable (IV) and system-Generalized Method of Moments (GMM) estimations are conducted on a panel of 68 developed and developing countries covering the period 1985-2005, using data on corruption perceptions taken from the International Country Risk Guide (ICRG). On the other hand, we run comparable Ordinary Least Square (OLS) and IV cross-section estimations on a sample of more than 9000 firms clustered in 23 developing countries, using data on bribes paid by firms drawn from the World Bank Enterprise Survey (WBES). Country-level and firm-level estimates provide evidence of nonlinear *ex post* and *ex ante* effects of instability, depending on the frequency and size of export fluctuations and on the liquidity constraint faced by economic agents.

The next section presents our conceptual framework. Section 3 presents the data and our empirical approach. In sections 4, 5, 6, and 7 we expose and comment our main empirical results. Section 8 concludes.

2. Conceptual framework: how does volatility impact corruption levels?

Following the distinction between household's responses to income instability proposed by Elbers et al. (2007), we posit there exists *ex post* and *ex ante* effects of export instability on corrupt behaviours. The *ex post* effect of instability refers to the agent's experience of instability and its consequences on income and welfare. As for the *ex ante* effect, it refers to agent's perception of instability and the way he adjusts his behaviour to lower his exposure to it, regardless the actual impact of shocks.

2.1 The *ex post* effects of volatility on corruption

In regards to the *ex post* effect of instability, we invoke two main competing corruption responses to income shocks: opportunistic corruption, which stems from the mechanical ups and downs in public and private rents induced by export transitory movements; and survival corruption, which arises from the necessity to relax the liquidity/budgetary constraint during hardships. While both mechanisms result from individuals' experience of instability, only the latter can be, strictly speaking, referred as a coping or smoothing mechanism. These two effects are expected to act in opposite ways. The direction and strength of the resulting net effect are therefore a priori uncertain.

Opportunistic corruption

As stressed by Voors et al. (2011) and Gokcekus and Suzuki (2011), positive shocks increase opportunities for corrupt transactions, which may incite agents to intensify their efforts to accumulate wealth through corrupt activities. Conversely, adverse shocks reduce the number and/or the size of rents of which public and private agents were or would have unduly taken advantage.

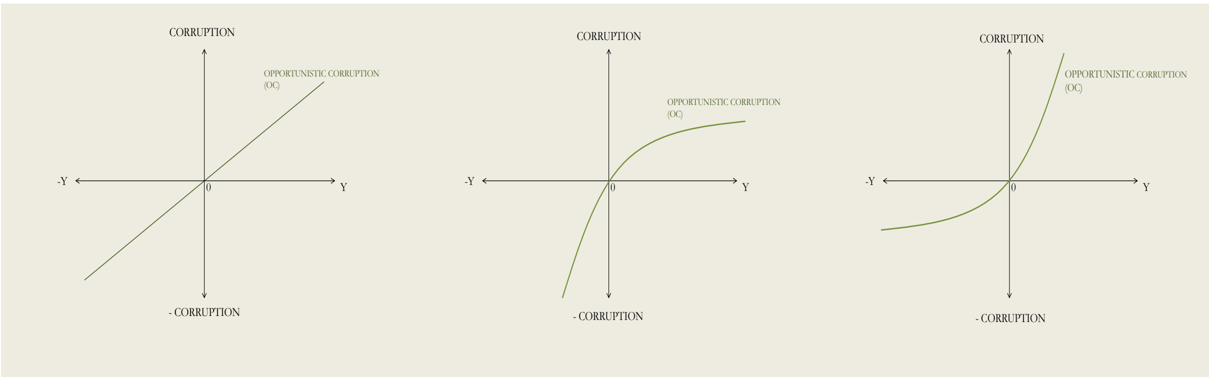
The literature on the natural resource curse provides striking illustrations of how 'voracious' appetites for wealth accumulation are stimulated by resource expansions. For instance, important rises in international raw material demand may undermine the rule of law and reorient economic activity toward rent-seeking activities (Van der Ploeg, 2011, 2010; Arezki and Brükner, 2010; Isham et al., 2005). Van der Ploeg (2010) also shows that, in natural resource rich countries, a precautionary motive may lie behind oil rent extraction during temporary oil-demand positive shocks. By extrapolation, it is plausible that favourable export shocks also give liquidity-constrained agents the incentive to insure themselves against future economic collapses, by engaging in corrupt activities during 'good years' and spending the resulting corruption proceeds during 'bad years'.

In a more general setting, public and private agents are likely to accumulate extra-wealth through bribery, extortion or embezzlement when opportunities for corrupt transactions flourish. Therefore, opportunistic corrupt behaviours are expected to be pro-cyclical, i.e. spreading during positive shocks and decreasing during negative shocks. In figure 1, we propose a very simple graphical representation of the relationship between transitory income and opportunistic corruption. Graphs displayed in figure 1 illustrate three scenarios, according to which the marginal effect of transitory income (or income shocks) on opportunistic corruption is either:

i) **constant**, depicting a standard situation where corruption rises in same proportion as transitory income increases;
ii) **decreasing**, which may illustrate situations where the opportunity cost of engaging in additional corrupt transactions decreases as income gets bigger and access to legal income-generating activities is better off, or where the probability of being detected and sanctioned rises with the size or occurrence of corrupt transactions;
iii) or **increasing**, which may characterize situations where the appetite for accumulation of corrupt actors intensifies as their transitory wealth increases. It may also apply to situations where the profitability of corrupt activities rises with the size and frequency of transactions (Bardhan, 1997), and when the incentive to engage in corrupt transactions increases with the number of corrupt agents (Andvig and Moene, 1990).

Figure 1. The effect of export shocks on 'opportunistic' corruption

i) constant marginal effect *ii) decreasing marginal effect* *iii) increasing marginal effect*



Survival corruption

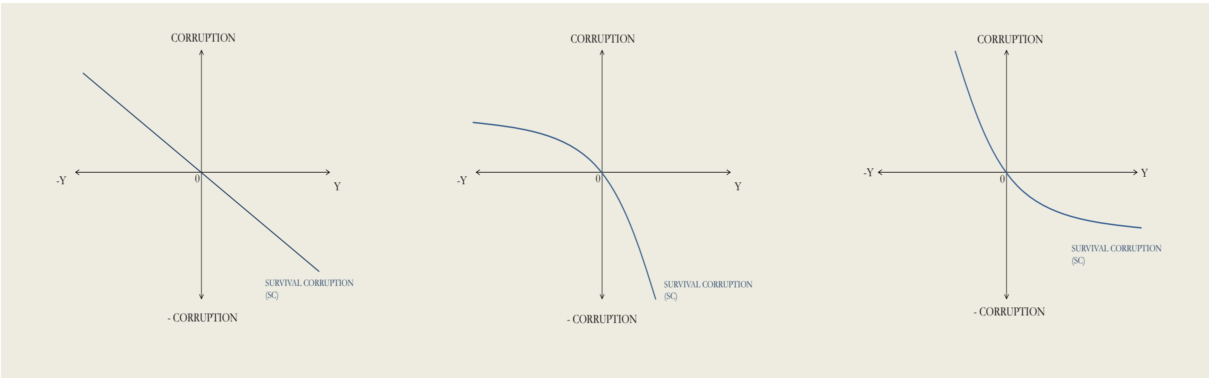
If the negative correlation between economic development and corruption prevalence has been widely emphasised (see for instance Treisman, 2000), the possibility of contra-cyclical variations in corruption levels has been less considered by the literature. Yet, various microeconomic surveys show that during negative income shocks, usual productive activities may not enable households to maintain their standard of living, so that labour supply adjustments represent an appealing strategy to earn extra income (Dercon, 2002). Interestingly, in a recent study, Robinson and Yeh (2009) show that transactional unprotected but better compensated sex is a way chosen by sex workers in Kenya to cope with health shocks, when formal and informal risk coping mechanisms do not allow them to fully smooth consumption.

Thus, adverse transitory shocks may lead liquidity-constrained agents to engage in corrupt activities in order to cushion income losses. For instance, during economic downturns, public officials may require firms to pay higher and/or more frequent bribes to complete their income. Similarly, firms under economic stress may be prone to fraud and bribery in order to avoid taxation, to get business or export licenses, to evade red tape, or to smuggle. Therefore, if the 'survival' motive prevails, corruption should increase during economic downturns when the liquidity constraint hardens, and should decrease during economic upturns when the liquidity constraint softens. As illustrated in figure 2, we consider that the marginal effect of income shocks on survival corruption can be either:

i) **constant**, which depicts a standard situation where corruption decreases in the same proportion as transitory income declines;
ii) **decreasing**, which may illustrate the decreasing marginal return of efforts to corrupt when rents become scarcer and competition for them intensifies. It may also reflect a probability of being detected and sanctioned increasing with the size of corrupt transactions, because of stronger checks and balances during hard times (Brückner and Ciccone, 2011; Galbraith, 1997). Or, this decreasing marginal effect of shocks may reflect situations where access to legal risk coping mechanisms is good, thereby increasing the opportunity cost of engaging in additional survival corrupt transactions.
iii) Or **increasing**, which may characterize situations where institutional safeguards against corruption fall as growth collapses, encouraging the impunity for acts of corruption. It may also reflect situations where formal and informal traditional risk coping mechanisms that are typically available to people are dysfunctional, and where illegal or risky activities such as corruption represent one of the few remaining options to cope with adverse shocks and minimize income losses.

Figure 2. The effect of export shocks on 'survival' corruption

i) constant marginal effect *ii) decreasing marginal effect* *iii) increasing marginal effect*



By reassembling these corrupt patterns in a unified analytical framework, we derive testable hypotheses on the relationship between export shocks and corruption. We depict in figure 3 four main situations yielding four different corruption outcomes. Graphs 3i) and 3ii) depict the simplest cases, where the marginal net effect of shocks is constant and corruption responses are symmetric, yielding:

i) **a positive net effect of shocks on corruption**: variations in opportunistic corruption (OC) during positive and negative shocks outweigh variations in survival corruption (SC).

ii) **a negative net effect of shocks on corruption**: variations in SC during positive and negative shocks outweigh variations in OC.

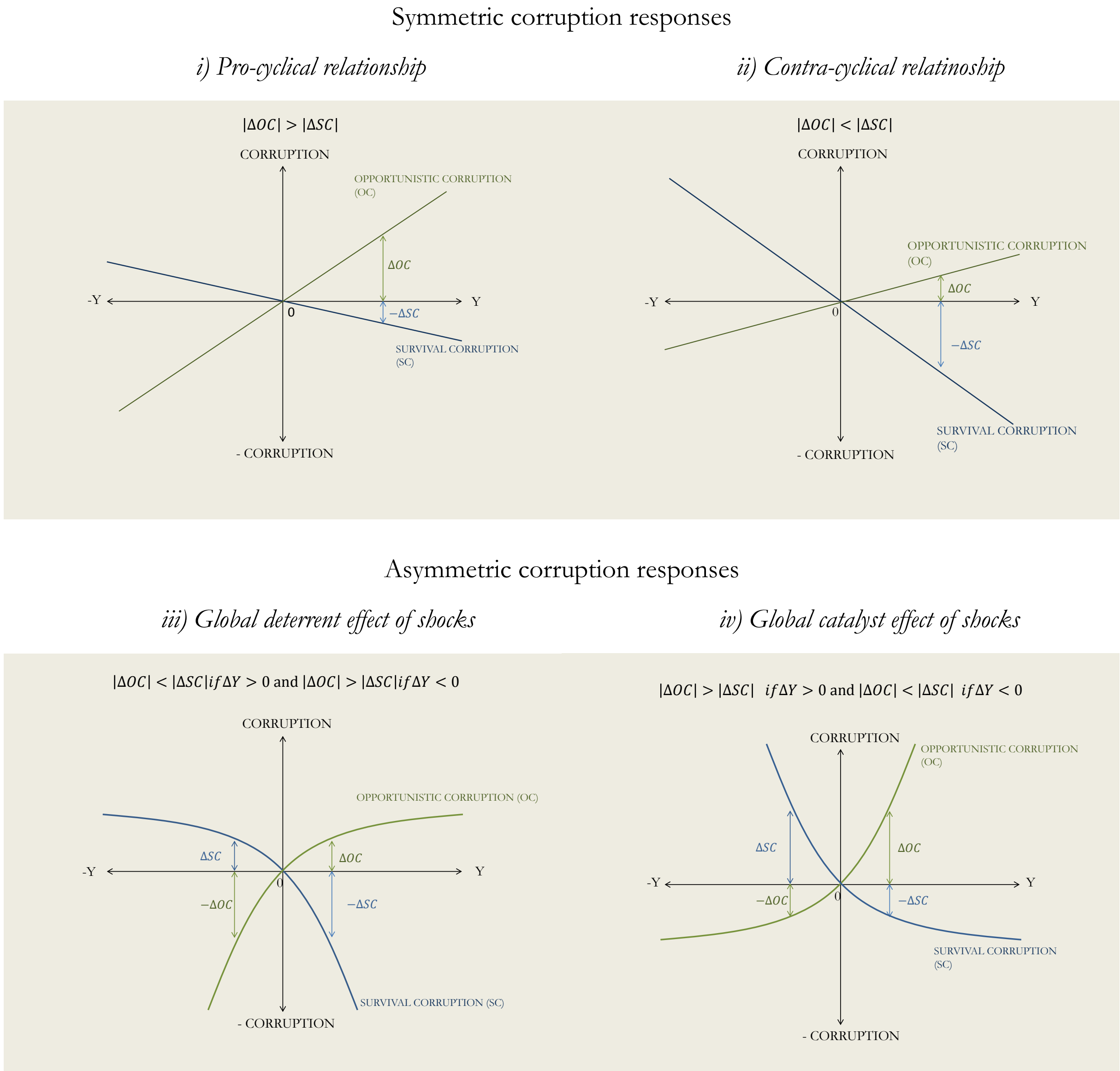
In graphs 3iii) and 3iv), we relax the linearity assumption upon the marginal effect of shocks on corruption, asymmetric responses to shocks emerge and yield more complex corruption patterns:

iii) **a 'global deterrent' effect of shocks on corruption**: when the marginal effect of income shock is decreasing, OC outweighs SC during negative shocks while SC outweighs OC during positive shocks. As a result, corruption decreases during both positive and negative shocks.

iv) **a 'global boosting' effect of shocks on corruption**: when the marginal effect of income shocks is increasing, SC outweighs OC during negative shocks while OC outweighs SC during positive shocks. As a result, corruption spreads during both positive and negative shocks.

To sum up, when the relationship between corruption and shocks is linear, corruption may be pro-cyclical or contra-cyclical, depending on the relative prevalence of opportunistic or survival corruption. When the linearity assumption is relaxed, economic instability may have either a 'global deterrent' *ex post* effect or a 'global boosting' *ex post* effect on corruption, depending on the marginal effect of shocks on corruption.

Figure 3. The ex post effects of volatility on corruption



2.2 The *ex ante* effect of volatility on corruption

The *ex ante* effect of instability refers to agents' productive decisions aimed at reducing revenue exposure to economic fluctuations (Dercon, 2002). Income smoothing strategies consist in reducing the risk in the income process by, for example, diversifying production choices, or re-orienting production toward lower-return but lower-risk activities. Business literature on the effects of cultural orientations on corrupt schemes also emphasises that an uncertainty avoidance motive for corruption may operate, especially in cultures where the aversion for uncertain or unknown situations prevails (Husted, 1999, Robertson and Watson, 2004).

From a rent-seeking perspective, it can be asserted that bribes are paid by economic agents to ensure the control of resource inflows over a given timeframe. Resource-locking corruption strategies can therefore be undertaken to maintain current and future revenue inflows, thereby reducing the variance of income over a certain period. Thus, when macroeconomic instability undermines the predictability of the government's fiscal policy, creating uncertainty upon the allocation of resources at different layers of the government, public officials may bribe higher-level public agencies in order to secure the allocation of such resources. The instability of output generates similar incentives for private agents. For instance, private firms may be inclined to secure the attribution of public tenders through bribery or other corrupt arrangements, thereby securing future revenue inflows over time. For the same reason, they may also be incited to unduly influence governments and legislators to initiate and pass laws that give effect to their interest in trade protections or favourable economic regulations (Grossman and Helpman, 1994). This point is corroborated by the recent work of Arin et al. (2011), who show that during serious attempts to correct fiscal imbalances, corrupt governments are less likely to cut spending than honest ones, since the former have "higher incentives to keep expenditures large (…) in order to accommodate the interests of influential lobbies".[1] That is why we expect resource-locking corruption to be an appealing income smoothing corrupt strategy, spreading (lessening) in environments with high (low) output instability.

3. Data and methodology

3.1 Corruption data

In this paper, we try to systematically provide comparable and consistent empirical country-level and firm-level evidence of corruption mechanisms described previously. On the one hand, we use a measure of corruption perception drawn from the International Country Risk Guide (ICRG), provided by the Political Risk Service (PRS) group. This measure is constructed by a network of country experts and assesses corruption in the political and (to a lesser extent) administrative spheres. It measures corruption as a risk for business by assessing to what extent it may take the form of excessive patronage, nepotism, job reservations, 'favour-for-favours', secret party funding, suspiciously close ties between politics and business, or bribes. The ICRG ranges from 0 (higher corruption level) to 6 (lower corruption level). Whilst the ICRG corruption indicator takes into consideration low-level bureaucratic corruption, it insists on corruption prevailing in the political arena or high levels of the administration, which makes this indicator rather political-oriented. For the ease and convenience of result interpretation, we reversed the score of the ICRG indicator, a high score corresponding to a higher level of corruption and *vice versa*.

As for the WBES data, it provides a comprehensive and comparable-internationally firm-level assessment of business environment conditions around the world, based on a survey administered to around 130 000 companies in 135 countries. Notably, the WBES provides a wide range of data

[1] in Arin, K.P., Chmelarova, V., Feess, E., and A. Wohlschlegel (2011), "Why are corrupt countries less successful in consolidating their budgets?", *Journal of Public Economics*, Vol.95, No.7-8, p.529.

highlighting the burden of corruption for private firms along with key other firm-level characteristics. In our study, we use a measure of experiences of corruption in conducting business, based on firm's informal payments in percent of total sales.[2]

3.2 Measuring volatility

As stressed earlier, the *ex post* effect of volatility relies on agent's experience of volatility, reflecting the consequences of shocks on well-being or firms' performance, while the *ex ante* effect of volatility depends on agents' perception of it (Elbers et al, 2007; Guillaumont, 2010). To test the *ex ante* and *ex post* effects of instability, we use two measures of instability based on the distribution of export earnings in constant dollar, y_t around a 16-years rolling mixed trend, $\hat{y}_{it}$. Considering the export process exhibits both deterministic and stochastic paths,

$$y_t = \chi_0 + \chi_1 t + \chi_2 y_{t-1} + \xi_t \text{ with } \xi_t \text{ a zero-mean i.i.d disturbance term,}$$

We estimate each year and for each country, over the current and past 15 years, trend values $(\hat{y}_{it})$ as follows,

$$\hat{y}_t = \hat{\chi}_0 + \hat{\chi}_1 t + \hat{\chi}_2 y_{t-1} \quad (1)$$

where *t* is a time trend. We consider the distribution of exports around this trend as stationary, hence reflecting only transitory variations in export proceeds (Cariolle, 2012).

The *ex post* effect of volatility ($Skewness_{it}$)

The empirical literature generally analyses the *ex post* effect of instability using annual shock variables, reflecting the impact of positive or negative shocks on economic decisions (Dercon, 2002). As stressed by Voors et al. (2011), there may be a time dyssynchrony between export shocks – which are annual events in our dataset – and variations in corruption scores – which are of longer periodicity. The literature introduces lagged shock variables to study their impact on institutional variables (Brückner and Ciccone, 2011; Voors et al, 2011). However, this approach presents the major drawback of overlooking the effect of repeated or persistent shocks on economic performances. Therefore, the shock-variable approach is likely to understate the lasting effect of persistent or repeated shocks, especially their effect on institutional outcomes such as corruption, which is known to change rather slowly over time.

[2] Enterprises were asked the following question: "We've heard that establishments are sometimes required to make gifts or informal payments to public officials to 'get things done' with regard to customs, taxes, licenses, regulations, services etc. On average, what percent of total annual sales, or estimated total annual value, do establishments like this one pay in informal payments or gifts to public officials for this purpose?"

To circumvent these potential drawbacks, we use an alternative measure of experienced instability, based on the 6-year rolling skewness of the distribution of exports around their trend:

$$Skewness_{it} = 100 \times \frac{\frac{1}{T}\sum^{T}\left(\frac{y_{it}-\hat{y}_{it}}{\hat{y}_{it}}\right)^{3}}{\left(\frac{1}{T}\sum^{T}\left(\frac{y_{it}-\hat{y}_{it}}{\hat{y}_{it}}\right)^{2}\right)^{3/2}} \quad with\ T = [t;\ t\text{-}5] \qquad (2)$$

Where y_{it} is the observed value of export in country *i* at time *t*, and $\hat{y}_{it}$ the rolling mixed trend.

First, the skewness provides a *de facto* measure of the asymmetry of shocks around a reference value (Rancière et al., 2008). Because this measure reflects the asymmetry of shocks, this measure captures an eventual persistent effect of repeated negative or positive shocks. Second, the skewness is also a measure reflecting the frequency and intensity of fluctuations. Indeed, an increase in the value of the skewness corresponds to an increase in the size or in the frequency of positive shocks compared to negative ones. Rancière et al. (2008) show that high values of skewness are strongly associated with the occurrence of crisis (if negative) or boom (if positive) in a large sample of countries over 1960-2000. They stress the strong link between the skewness and the kurtosis of a distribution, the latter reflecting the fatness of the tails or the peakedness of a distribution.

Annex B.1 supports this statement, by showing strong correlations between absolute values of skewness and values of kurtosis.[3] Annex B.2 illustrates the relationship between export skewness, and corruption in Cameroon, Argentina, Indonesia and Bangladesh. It can be observed in these countries that the evolution of the skewness of exports fits quite well with the evolution of corruption scores, revealing pro-cyclical relationships in Cameroon and Argentina, and contra-cyclical relationships in Indonesia and Bangladesh.

Thus, our skewness-based measure of instability is expected to reflect two major dimensions of the experience of economic instability: on the one hand, the asymmetry of shocks; and on the other hand, the frequency and size of export fluctuations. In other words, while a high negative value of skewness reflects the predominance of low-frequency large-size negative fluctuations, a small positive value of skewness reflects the predominance of high-frequency small-size positive fluctuations. This measure therefore seems particularly appropriate to reflect the consequence or experience of shocks on welfare.

---

[3] The kurtosis is a measure of both the peakedness and tails' fatness of a random variable's probability distribution. The kurtosis measures the extent to which observed values far from the mean (or their trend) are frequent in comparison to those in the neighborhood of the mean (or their trend). We compute the *k*-year rolling kurtosis of exports as follows:

$$Kurtosis = 100 \times \frac{\frac{1}{T}\sum_{t}\left(\frac{y_t-\hat{y}_t}{\hat{y}_t}\right)^{4}}{\left(\frac{1}{T}\sum_{t}\left(\frac{y_t-\hat{y}_t}{\hat{y}_t}\right)^{2}\right)^{2}}$$

with T = [t; t-k], y_t the observed value of export earnings and $\hat{y}_{it}$ their trend value.

The ex ante effect of volatility (VAR_{it})

The *ex ante* effect of instability refers to adjustments in agents' behaviours aimed at lowering the variability in their income, regardless the impact of output fluctuations on agents' wealth or well-being (Elbers et al., 2007). As suggested by Elbers et al. (2007), we look for a measure reflecting agents' *perception* of instability. We compute this measure as the 16-year rolling standard deviation of exports around the rolling mixed trend $\hat{y}_{it}$ in country *i* at time *t*:

$$Std\_dev_{it} = 100 \times \sqrt{\frac{1}{T}\sum^{T}\left(\frac{y_{it} - \hat{y}_{it}}{\hat{y}_{it}}\right)^2} \quad with\ T = [t; t\text{-}15] \qquad (4.3)$$

We expect it to be an adequate approximation of agent's changing perception of aggregate output variance. By computing the standard deviation of exports on a rolling basis and over a long time frame, we allow the perception of instability to change over time while giving equal weights to remote and present fluctuations. In other words, this measure limits the influence of contemporaneous sharp export movements on agents' perception of instability, while capturing the lasting influence of remote fluctuations. We expect this measure to give more prominence to the way agents perceive instability than the way they actually experience it. Annex B.3. illustrates the respective evolution of corruption levels and the 15-year standard deviation of exports in Thailand, France, Italy and Spain. It can be observed in these countries that the evolution of corruption score clearly tracks that of the standard deviation of exports.

3.3 Other data

We estimate the effects of export instability on corruption with two econometric models. On the one hand, we set a dynamic panel framework using panel data on corruption perceptions in 68 developed and developing countries over the period 1985-2005. On the other hand, we conduct cross-section estimations using micro data on informal payments made by more than 9000 firms, interviewed between 2008 and 2011, clustered in 23 developing countries. Descriptive statistics and data sources are presented in annex A.

We approximate the effect of the economic development process on corruption, by using variables capturing the structural long-term determinants of growth evidenced by Sala-i-Martin et al. (2004). In our empirical specifications, we include the annual growth rate of the population as a proxy for human capital conditions. We expect low demographic growth rates to result from a healthy and educated population, while high growth rates to characterize countries with low human capital which have not achieved their demographic transition. We also use the share of governmental spending in GDP as a proxy for the effect of public sector size on growth and income levels. We include a measure of total natural resource rents (in % of GDP) to account for the effect of natural resources endowments on long term growth.

In panel country-level regressions, we expect the country fixed effect to capture the effect of time invariant unobserved country characteristics, as well as time invariant growth determinants found significant by Sala-i-Martin et al. (2004) in their growth regressions. In cross-section firm-level regressions, we control for the initial income level using the twenty-year lagged GDP *per capita*, and account for the effect of geography by including the country latitude, and dummies for landlockness and regional location. Following La Porta et al. (1999), we also include a dummy equal to one for common-law based legal systems and zero otherwise.

In addition, we control for usual determinants of corruption identified by the literature (Treisman, 2000; Tanzi, 1994; and Mauro, 2004),: *trade openness*, *democracy*, the *political regime stability* (using a regime durability variable), and the *logarithm the population*. It is worth reminding that many variables may both explain long term income growth and corruption, e.g. natural resources (Van der Ploeg, 2011, 2010; Isham et al., 2005) or state interventions (Tanzi, 1994; Guriev, 2004). In cross-section regressions, following the literature on business corruption using firm-level surveys (Clarke, 2011; Jensen et al., 2010; Kaplan and Pathania, 2010), we also control for the firm's size, public ownership (in % of firms), and export orientation (% of direct and indirect exports in total sales).

3.4 Baseline estimation framework

Following Elbers et al. (2007), we estimate the *ex post* and the *ex ante* effects by respectively including in a corruption equation our measures of skewness and standard deviation of exports along with other control variables:

$$Corrupt_{it} = \alpha_0 \, [+\alpha_1.Corrupt_{it-1}] + \boldsymbol{\alpha_2.Skewness_{it}} + \boldsymbol{\alpha_3.Std\_dev_{it}} + \alpha_4.Macro\_controls_{it}$$
$$\{+\alpha_5.Micro\_controls_{it} + \alpha_6.timefixed\_controls\} + \lambda_t \, [+ \mu_i \,] + \varepsilon_{it}, \qquad (4)$$

Variables in square brackets are included in country-level dynamic panel regressions only, while variables in curly brackets are included in firm-level cross-section estimations only. In panel regressions, $Corrupt_{it}$ is the ICRG indicator of corruption perception, while in cross-section regressions it represents the share of informal payments in total sales made by firm *i* interviewed at time *t*.

Thus, corruption is function of its lagged level (in panel regressions only)[4], the 6-year rolling skewness of exports, the 16-year rolling standard deviation of exports, macro-level control variables, micro-level and time-fixed control variables (in firm-level regressions only), time dummies, country fixed effects (in panel regressions only), and ε_{it} an i.i.d. error term. Finally, since firm-level regressions are cross-section regressions without any time dimension (the time subscript may be misleading), time dummies only control for the year of firms interview (2008, 2009, 2010 or 2011).

[4] This dynamic empirical framework allows capturing regression-to-the-mean effect, as well as persistence in corruption perception scores (Voors et al., 2011).

4. Baseline empirical results

Within fixed effect (FE), instrumental variable (IV), and sys-GMM panel estimations are applied to equation (4), using panel data from 68 developed and developing countries over 1985-2005 (1144 observations in baseline estimations). In parallel, Ordinary Least Square (OLS) and IV cross-section estimations with standard errors clustered by country are conducted on a sample of 9212 firms from 23 developing countries. To ensure that measurement errors, omitted variables, and reverse causality problems do not bias estimations, we systematically compare i) FE and OLS estimates with IV or sys-GMM estimates, and ii) panel country-level estimates with firm-level cross-section estimates. Results are presented in table 1.

4.1 Ordinary Least Square (OLS) and Fixed Effect (FE) estimates

Contrary to Voors et al. (2011), FE estimations of equation (4) in column (2) show a 10% significant negative net effect of the export skewness on corruption perceptions.[5] An increased experience of positive (negative) shocks significantly reduces (increases) country corruption scores, which supports the hypothesis of survival corruption prevalence. In contrast to panel estimations, OLS firm-level estimates in column (8) support the hypothesis of opportunistic corruption prevalence, as firms' informal payments are found to increase (decrease) with the experience of positive (negative) shocks.

Concerning the *ex ante* effect of instability on corruption, firm-level estimates in column (8) show a strong positive effect of the standard deviation of exports on firms' informal payments, which cannot be observed in FE estimates. Since the effect of the perception of instability on corruption may be observable on the long run rather than on the short run, cross-section regressions may reflect such a long term relationship better than the FE estimator does.

While *a priori* contrasting empirical evidence may simply reflect sample differences, or differences between the long run and the short run effects of instability, problems of reverse causality or omitted variable bias might have been misleading us. This issue is addressed in the following sub-section.

[5] The high between-R^2 in column (2) may result from problems of multi-colinearity between time dummies and export skewness, since universal time-related export shocks may have been captured by time dummies. We run FE estimation of equation (4) without them and find a more significant and stronger negative effect of export skewness on corruption score once time dummies are removed (see table 2 column (2), and table 4 column (2) and (4)).

Table 1 – Export instability and corruption: equation (4)

Dependent variable:	**ICRG**					**WBES**					
	Within fixed effects		IV-2SLS	GMM-CUE	Sys-GMM	OLS			IV-2SLS		GMM-CUE
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
Lagged Corruption	0.723***	0.695***	0.677***	0.706***	0.713***						
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)						
Export skewness		**-0.0002***	**-0.001**	**-0.001***	**-0.001***			**0.003†**	**0.002**	**0.003***	**0.004*****
		(0.10)	**(0.24)**	**(0.07)**	**(0.09)**			**(0.11)**	**(0.16)**	**(0.07)**	**(0.00)**
Export standard deviation		**-0.003**	**-0.051**	**-0.081****	**-0.050**			**0.654*****	**0.560*****	**0.230***	**0.361*****
		(0.77)	**(0.18)**	**(0.05)**	**(0.63)**			**(0.00)**	**(0.00)**	**(0.09)**	**(0.00)**
Population growth	-0.044	-0.039	0.015	0.090	-0.523	-0.463†	-0.423†	1.712***	1.374***	0.091	0.544
	(0.24)	(0.33)	(0.88)	(0.43)	(0.42)	(0.11)	(0.12)	(0.00)	(0.01)	(0.86)	(0.16)
Natural resources	0.007**	0.009***	0.010**	0.012**	0.047	-0.012†	-0.012	0.108***	0.089***	0.013	0.039*
	(0.04)	(0.01)	(0.05)	(0.02)	(0.29)	(0.14)	(0.17)	(0.00)	(0.00)	(0.65)	(0.07)
Government size	-0.011**	-0.013**	-0.018**	-0.017*	0.028	2e-11*	2e-11*	3e-11***	3e-11***	3e-11***	3e-11***
	(0.06)	(0.04)	(0.05)	(0.07)	(0.53)	(0.09)	(0.10)	(0.00)	(0.00)	(0.01)	(0.00)
Log population	0.718***	0.073	0.795	0.481	-2.013	0.545**	0.560**	0.438***			
	(0.00)	(0.79)	(0.14)	(0.40)	(0.28)	(0.04)	(0.03)	(0.00)			
Polity regime stability	0.001	-0.003*	-0.004**	-0.004*	0.025	-0.019***	-0.019***	0.005 (0.59)	-0.001	-0.006	-0.003
	(0.74)	(0.07)	(0.04)	(0.07)	(0.21)	(0.00)	(0.00)		(0.88)	(0.33)	(0.54)
Democracy	-0.015**	-0.018***	-0.010	-0.009	0.010	0.158*	0.165*	0.831***	0.728***	0.359*	0.518***
	(0.02)	(0.01)	(0.16)	(0.22)	(0.92)	(0.08)	(0.08)	(0.00)	(0.00)	(0.06)	(0.01)
Log openness	0.135	0.065	0.126	0.228	0.740	0.021**	0.021**	0.023***	0.024***	0.023***	0.025***
	(0.16)	(0.56)	(0.44)	(0.18)	(0.33)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)
Latitude						0.048***	0.048***	0.064***			
						(0.00)	(0.00)	(0.00)			
Landlocked						2.489***	2.480***	-2.316**			
						(0.00)	(0.00)	(0.02)			
Initial GDP per cap						0.809**	0.856**	1.395***			
						(0.02)	(0.02)	(0.00)			
Common Law						-11.26***	-11.05***	-2.869			
						(0.01)	(0.02)	(0.50)			
Firm size							-0.161**	-0.159**	-0.157**	-0.036	-0.039
							(0.04)	(0.05)	(0.03)	(0.52)	(0.47)
State owned							0.027	0.028	0.028	-0.005**	-0.006**
							(0.21)	(0.18)	(0.16)	(0.05)	(0.02)
Direct exports (% sales)							-0.001	-0.002	-0.001	0.004	0.005
							(0.54)	(0.44)	(0.51)	(0.41)	(0.24)

Indirect exports (% sales)							-0.002 (0.17)	-0.002 (0.31)	-0.001 (0.35)	-0.001 (0.20)	-0.001** (0.04)
Constant	-11.44*** (0.00)	3.763 (0.44)			30.36 (0.36)	-2.978 (0.53)	-3.362 (0.59)	-22.28*** (0.00)			
Country fixed effects	Yes	Yes	Yes	Yes	Yes	No	No	No			
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Region dummies	No	No	No	No	No	Yes	Yes	Yes			
Obs(countries/clusters)	1144 (68)	1144 (68)	700 (46)	700 (46)	1144 (68)	9212 (23)	9212 (23)	9212 (23)	9212 (23)	4210 (23)	4210 (23)
R-squared					Wald	0.083	0.084	0.084	0.02	0.02	0.02
Within	0.604	0.641	0.561	0.561	chi2(28) =						
Between	0.543	0.934			620						
Weak instrument test											
Kleibergen-Paap stat(critical value)			4.7 (21.7) [a]	4.7 (4.1) [a]					1.2(16.9)[a]	5.2(16.9)[a]	5.2(4.7)[a]
F-test of excluded instruments											
1st stage equation - export skewness			6.44	6.44					8.42	5.86	5.86
1st stage equation - export std_dev			6.97	6.97					12.25	9.23	9.23
Hansen test (p-val)			0.17	0.21	0.84				0.04	0.45	0.45
Endogeneity test (difference-in-Hansen test), Chi2 p-value:											
6-yr skew + 16-year std-dev exports			0.32							0.81	
6-yr skew			0.35							0.84	
16-year std dev of exports			0.14							0.58	
AR(1) test (p-val)					0.00						
AR(2) test (p-val)					0.20						
Number of instruments			6	6	49				4	4	4

Standards errors robust to heteroskedasticity in all regressions, and clustered by country for OLS firm-level estimations. In column (4) standard errors are robust to heteroskedasticity and autocorrelation of order 1. P-values in parenthesis. *significant at 10%; **significant at 5%; ***significant at 1% † significant at 14%. Hansen J-statistic tests for joint instrument validity; null hypothesis is that the instruments are valid, i.e., uncorrelated with the error term, and that instruments are correctly excluded from the second-stage equation. IV-estimates are adjusted for small sample bias.

In the sys-GMM estimation, time dummies are excluded instruments; the skewness of exports is treated as predetermined and instruments the differenced equation by its lagged levels (lags 1 to 10); the standard deviation is treated as endogenous and instruments the differenced equation by its lagged levels (lags 2 to 10); lagged corruption is treated as endogenous and instruments the equation in system by its lagged levels and differences (lags 2 to 11). Instruments are collapsed, orthogonal deviations are preferred to first-difference deviations, and the Windmeijer correction of the two-step estimated variance is applied.

In columns (9), (10), and (11), we partialled-out the 20-year lag GDP per capita, geographic and common-law system dummy variables, and the logarithm of population to make the covariance matrix of the orthogonality conditions full rank. In blue-colored columns (10), and (11) we restrict the sample to firms considering that corruption is not an obstacle or is a minor obstacle to their current operations.

a.When the Kleibergen-Paap statistic is below the Stock-Yogo critical value, then a standard significance test on estimated coefficient with nominal size of 5 percent has a maximal size of 10 percent or more.

4.2 Identification strategy

We conduct instrumental variable (IV) estimations with country-level and firm-level data to ensure that measurement errors, omitted variables or reverse causality problems do not bias our results. Then, we run system-GMM estimations to check whether the lagged dependent variable does not bias results in panel FE and IV regressions.

Instrumental Variable (IV) estimations

While instability in real export earnings is mainly structural for small "price-taker" countries, caused by natural or trade shocks, fluctuations in exports around their trend may be sometimes generated by unstable or poorly designed policies (Guillaumont 2010, 2009ab). Moreover, the conceptual framework exposed in section 2 underlines a possible direct contribution of corruption to export fluctuations, in particular when corrupt schemes prevail in the custom sector and impact export volumes. Our objective is hence to control for a possible reverse causality bias, but also for the omission of variables correlated with both export instability and corruption.

Building on a study on the climate origins of export movements (Jones and Olken, 2010) and on the literature addressing the causes and consequences of structural economic vulnerability (Guillaumont, 2010, 2009ab), we instrument the 6-year skewness and the 16-year standard deviation of exports using a set of climatic and natural disasters variables, and a variable reflecting country exposure to trade shocks. On the one hand, we instrument export instability by the contemporaneous and lagged values of the 6-year skewness and 16-year standard deviation of rainfall levels around their average value. Using rainfall data from *Global Air Temperature and Precipitation: Gridded Monthly and Annual Time Series* (Version 2.01)[6] treated by Guillaumont and Simonet (2011), we expect the instability in rainfall levels to be a direct internal cause of export instability in developing countries[7] (Jones and Olken, 2010). On the other hand, we use the annual share of people affected by natural disasters in the population as a second excluded instrument for export instability variables. The computation of this indicator follows a methodology based on the calculation of the homeless index used by the United Nations Committee for Development Policy (UNCDP) in its 2009 triennal review of Least Developed Countries. The computation method is detailed in annex C.1.

In IV-panel estimations, in addition to natural shock variables, we also use an index of country merchandize export concentration as excluded instrument. According to the UNCDP, merchandize

[6] From the Center for Climatic Research of the University of Delaware. Data is interpolated and documented by Cort J. Willmott and Kenji Matsuura, with support from IGES and NASA, University of Delaware (for more information see Matsuura and Willmott, 2007).

[7] This exclusion restriction may not hold if there is a direct effect of natural shocks on corruption passing through variations in domestic (not exported) incomes, infrastructure destructions, health damages. Brückner and Ciccone (2011) encountered the same kind of issue. In this case, this would lead to understate estimated causal effects of export instability on corrupt deals, since corruption mechanisms emphasised in section 2, such as survival corruption or resource-locking corruption strategies, are likely to operate in those contexts too.

export concentration increases a country's exposure to trade shocks and its structural vulnerability to them. Its computation method is presented in annex C.1.

First-stage estimation of the following system is conducted:

$$Skewness_{it} = \beta_0 \ [+\beta_1.Corrupt_{it-1}] \ + \boldsymbol{\beta_2.Natural\_shocks_{it}} \ \boldsymbol{[+ \beta_3.Concentration_{it}]} \ + \beta_4.Macro\_controls_{it} \ \{+ \beta_5.Micro\_controls_{it}+\beta_6.timefixed\_controls\} \ [+ \varphi_t + \chi_i \ ] \ +\upsilon_{it} \quad (4a)$$

$$Std\_dev_{it} = \beta'_0 \ [+\beta'_1.Corrupt_{it-1}] \ + \boldsymbol{\beta'_2.Natural\_shocks} \ \boldsymbol{[+ \beta'_3.Concentration_{it}]} \ + \beta'_4.Macro\_controls_{it} \ \{+ \beta'_5.Micro\_controls_{it}+\beta'_6.timefixed\_controls\} \ [+ \varphi'_t + \chi'_i] \ +\upsilon'_{it} \quad (4b)$$

where $Natural\_shocks_{it}$ and $Concentration_{it}$ are respectively the set of natural shock variables and the merchandise export concentration index. υ_{it} and υ'_{it} are random error terms.

In all regressions, we choose the combination of exogenous instruments that minimize under-identification and weak identification problems. In panel regressions, we instrument the 6-year skewness and the 16-year standard deviation of exports by the following set of instruments: the contemporaneous value and 4th lag of the 6-year skewness of rainfall levels, the contemporaneous value and 4th lag of the annual share of people affected by natural disasters, the contemporaneous value of the 16-year standard deviation of rainfall level, and the contemporaneous value of the merchandize export concentration index. As the export concentration index has been calculated for a panel of 128 developing countries from 1984 to 2008 in Cariolle (2011), developed countries are excluded from IV panel estimations.

In cross-section firm-level IV estimations, our instrument set consists of: the 2008 and 2004 lagged value of the 6-year skewness of rainfall levels, the 2008 value of the 16-year standard deviation of rainfall levels. The 2005 value of the annual share of people affected by natural disasters, which has the strongest correlations with instrumented variables.

IV country-level panel estimates

Second stage country-level panel estimates are presented in columns (3) and (4) of table 1. First stage results are displayed in annex C.2. Two-Stage Least Square (2SLS) estimates of equation (4) are displayed in column (3). If the Hansen test does not reject the validity of our instrument set, endogeneity tests do not reject the null hypothesis that export instability variables can actually be treated as exogenous, in a 10% confidence level. However, the difference-in-Hansen test conducted on the standard deviation of export alone rejects the null of exogeneity in a 14% confidence level. It is therefore plausible that estimates of the *ex ante* effect of export instability on corruption are biased.

Low F-tests and Kliebergen-Paap statistics suggest that our instrument set is weakly correlated with the two measures of export instability. To address this problem of weak instruments bias, we perform the Continuously Updated GMM Estimator (CUE), which is an estimator robust to weak instrument problems and heteroskedasticity of unknown form (Hansen et al. (1996)). Results are presented in column (4). Hansen and Kliebergen-Paap tests do not reject the validity of our instrument set. CUE-GMM estimates support a significant negative effect of both the 6-year skewness (7% significant) and the 16-year standard deviation of exports (5% significant) on corruption perceptions.

IV firm-level cross-section estimates

Second-stage firm-level IV estimates are presented in columns (9), (10), and (11) of table 1. First-stage results are displayed in annex C.2. In column (9), estimates do not provide evidence of a significant *ex post* effect of export instability on corrupt transactions, in the usual confidence levels. While F-tests of excluded instruments suggest that instrumental variables have a reasonable explanatory power, the Hansen test rejects with a 6% confidence level the validity of our instrument set. Here, the non-violation of orthogonality conditions relies on the hypothesis that country-level natural shock variables impact a firm's corruption expenses through its own income fluctuations. This hypothesis may be unrealistic since a firm's bribe payments may be caused by variations in other economic agents' income. For instance, rainfall-induced export shocks may incite custom officers to extort higher bribes to firms, or may incite a firm to engage in corruption because of an intensified competition from other firms for economic rents. It is therefore likely that the validity of our instrument set is rejected because a firm's informal payments also result from the pressure exerted by other agents affected by common natural shocks. One solution to this problem may consist in restricting the sample to firms which engage proactively in corrupt transactions ('active' firms). Indeed, firms which bribe without feeling compelled to do it are expected to engage in corruption because of fluctuations in their own income rather than in other economic agents' income. To distinguish 'passive' firms from 'active' ones, we combine WBES data on firms' informal payments with WBES data on firms' perception of corruption. We expect that firms considering corruption as "no obstacle" or "a minor obstacle" for their business to be potential proactive corrupters if they declare in parallel making informal payments.[8] We perform the same 2SLS estimation of equation (4) on a sample of potentially "active" firms (also including firms which declared paying no bribes but considered corruption as no obstacle or a minor obstacle to their business).

Results are exposed in column (10). The Hansen test does not reject the null hypothesis of instrument orthogonality, which tends to advocate the relevance of our identification strategy.[9] Endogeneity tests do not reject the null hypothesis that export instability variables can actually be treated as exogenous, in a reliable confidence level. Estimates show a 10% significant positive effect of the instrumented export skewness on corruption expenses, similar to that estimated in

[8] Interviewed firms have been asked whether they perceive corruption as an obstacle to business, and to what extent. They were asked the following question: "Is corruption 'No Obstacle', a 'Minor Obstacle', a 'Moderate Obstacle,' a 'Major Obstacle', or 'a Very Severe Obstacle' to the current operations of this establishment?".

[9] 2SLS estimation of equation (4) has also been conducted on the remaining sample of firms, i.e. firms considering corruption as at least a moderate obstacle to their business. Results are presented in the last column of annex C.2, and the corresponding Hansen-J statistic significantly rejects the hypothesis of instruments validity.

OLS regression. They also support a 10% significant positive effect of the instrumented standard deviation of exports on corrupt transactions.

However, F-tests of excluded instruments and the Kleibergen-Paap statistic are low, which still casts doubts on the consistency of 2SLS estimates. To address a possible weak instrument bias, we again perform the Continuously Updated GMM Estimator (CUE), robust to non-i.i.d disturbances. Results are presented in column (11) and suggest that the strength and significance of estimated instability coefficients were understated in 2SLS estimations.

System GMM estimations

We provide further empirical evidence on the causal effects of export instability on corruption by applying the dynamic panel GMM estimator to equation (4). Details on the sys-GMM procedure are provided in table 1. Results are presented in column (5). Estimates pass the Hansen test of identification and the Arellano-Bond test of two-order autocorrelation in a reliable confidence level, and confirm the significant negative *ex post* effect of export instability on corruption perceptions observed in FE estimations. In particular, despite differences in the sample (in sys-GMM estimations, developed countries are not excluded from the sample) and in the instrumentation technique, estimates of the lagged dependent variable and the skewness variable are strikingly similar to those obtained in IV estimations (columns (3) and (4)).[10] However, the 16-year standard deviation of exports does not appear significant in sys-GMM estimations, which contrasts with previous GMM-CUE estimates.

Despite methodological and sample differences, GMM and IV panel estimations both point to a negative *ex post* effect of instability on corruption perceptions, similar in strength and in significance, suggesting that survival corruption responses prevail over opportunistic corruption responses to export fluctuations. By contrast, IV cross-section estimations point to a positive *ex post* effect of instability on firms' informal payments, suggesting that opportunistic corruption responses prevail over survival corruption responses to export fluctuations. We also find contrasting evidence of an *ex ante* positive effect of export instability on corruption perceptions and firms' bribe payments. Suspecting that such contrasting effects are driven by sample differences and reflect nonlinear rather than inconsistent estimates, we address in the next section potential nonlinearities in the effects of instability on corruption.

[10] Suggesting that the bias in the value of the estimated coefficient potentially induced by an indirect effect of natural shocks passing through other channels than the export channel is somewhat limited.

5. Disentangling the *ex post* and *ex ante* effects of instability on corruption

In a first sub-section, we insert simultaneously in the corruption equation a variable of positive skewness and a variable of negative skewness, to account for possible asymmetric *ex post* effects of shocks and asymmetric corruption responses to them. In the second and third sub-sections, we show that the direction of the *ex post* and *ex ante* effects of export instability on corrupt deals depends on the size and frequency of export fluctuations.

5.1. Disentangling the *ex post* effect of instability: accounting for the asymmetry of export fluctuations

Following Rancière et al. (2008), we insert the negative and the positive skewness of exports together in the corruption equation. The negative (positive) skewness of export is computed as a variable equal to the absolute value of skewness if the latter is negative (positive) and equal to zero otherwise. By doing this, we can identify *asymmetric effects* of positive and negative shocks – by looking at the relative *strength* of estimated coefficients – and *asymmetric corruption responses* to positive and negative shocks – by looking at the *sign* of estimated coefficients. We therefore estimate the following corruption equation:

$$Corrupt_{it} = \alpha_0 \; [+ \; \alpha_1.Corrupt_{it-1}] \; + \; \boldsymbol{\alpha_{2a}.Positive\_skewness_{it}} \; + \; \boldsymbol{\alpha_{2b}.Negative\_skewness_{it}} \; + \; \alpha_3.std\_dev_{it} \; + \; \alpha_4.Macro\_controls_{it} \; \{+ \; \alpha_5.Micro\_controls_{it} + \alpha_6.timefixed\_controls\} + \lambda_t \; [+ \; \mu_i] \; + \varepsilon_{it} \qquad (5)$$

Results are presented in table 2. Both country-level and firm-level estimations support a 'global deterrent' *ex post* effect of export instability on corruption. This evidence is consistent with the assumption presented in sub-section 2.1 of a decreasing marginal effect of transitory shocks on corruption practices, yielding *asymmetric corruption responses* to shocks. Moreover, difference in the respective deterrent *effect* of positive and negative shocks explains why previous panel and cross-section estimations of the *ex post* 'net' effect of instability were ambiguous in table 1. If the deterrent effect of adverse shocks is not significant in a 10% confidence level in FE and GMM estimations, OLS firm-level estimation conducted on the original sample of firms (column (4)) shows that adverse shocks have a stronger deterrent effect on corruption than positive shocks.

In what follows, we further disentangle the *ex post* effects of export instability on corruption by testing whether the decreasing or increasing nature of the marginal effect of shocks, and therefore the direction of estimated relationships, depends on the size and frequency of export fluctuations.

5.2. Disentangling the *ex post* effects of instability: accounting for the size and frequency of export fluctuations

Following Alderman (1996), Dercon (2002), or Collier (2002), we think that the direction of the *ex post* effect of instability may differ according to the destabilizing nature of output variations. As Dercon (2002, p.2) points out,

> "Other characteristics of income risk include the frequency and intensity of shocks, and the persistence of their impact (…). Relatively small but frequent shocks are more easily to deal than large, infrequent negative shocks."

Table 2 – Asymmetric reactions to experienced volatility

Dependent variable:	**ICRG**			**WBES**	
	Within fixed effects		Sys-GMM	OLS	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Lagged Corruption	0.694*** (0.00)	0.714*** (0.00)	0.700*** (0.00)		
Export skewness > 0	**-0.0006* (0.06)**	**-0.001*** (0.01)**	**-0.001** (0.02)**	**-0.004* (0.08)**	**0.002 (0.61)**
Export skewness < 0	**-0.0002 (0.38)**	**-0.0003 (0.46)**	**-0.001 (0.22)**	**-0.013** (0.02)**	**-0.004 (0.47)**
Export std_dev	-0.001 (0.89)	0.001 (0.93)	-0.001 (0.99)	0.813*** (0.00)	0.213 (0.28)
Country fixed effects	Yes	Yes	Yes	No	No
Time dummies	Yes	No	Yes	Yes	Yes
Observations (countries/clusters)	1144 (68)	1144 (68)	1144 (68)	9212 (23)	4283 (23)
R-squared				0.083	0.10
Within	0.642	0.609	Wald chi2(29) =		
Between	0.954	0.612	679		
Hansen test (p-val)			0.36		
AR(1) test (p-val)			0.00		
AR(2) test (p-val)			0.32		
Number of instruments			55		

Controls not reported. When possible, coefficients are rounded to three decimal places. Standards errors robust to heteroskedasticity in all regressions, and clustered by country for OLS firm-level estimations. P-values in parenthesis. *significant at 10%; **significant at 5%; ***significant at 1%. Hansen J-statistic tests for joint instrument validity; null hypothesis is that the instruments are valid, i.e., uncorrelated with the error term, and that the excluded instruments are correctly from the second-stage equation. In the sys-GMM estimation, time dummies are excluded instruments; the skewness of exports is treated as predetermined and instrument the differenced equation by its lagged levels (lags 1 to 9); the standard deviation of exports is treated as endogenous and instrument the differenced equation by its lagged levels (lags 2 to 9); lagged corruption is treated as endogenous and instrument the equation in system by its lagged levels and differences (lags 2 to 10). Instruments are collapsed, orthogonal deviations are preferred to first-difference deviations, and the Windmeijer correction of the two-step estimated variance is applied. Hansen J-statistic tests for joint instrument validity; null hypothesis is that the instruments are valid, i.e., uncorrelated with the error term, and that the excluded instruments are correctly from the second-stage equation.

Opportunistic corruption may prevail over survival corruption during sudden and sharp transitory booms, when usual institutional safeguards against malpractices are overwhelmed by rent-seeking behaviours. Conversely, survival corruption is also likely to prevail during sharp unexpected busts, when usual coping mechanisms cannot fully absorb their negative consequences on income or welfare.

However, institutional and financial constraints may not bind during normal fluctuations, which may increase the opportunity cost of engaging in corruption during moderate positive shocks while enabling agents to (at least partly) cope with the consequences of moderate adverse shocks on income. It is therefore likely that the decreasing or increasing nature of the marginal effect of exports shocks on corruption, illustrated in graphs 4iii) and 4iv) of section 2.1, depends on the destabilizing nature of export variations.

To account for nonlinear *ex post* effects reliant on the abruptness of export fluctuations, we introduce together in the corruption equation the quadratic terms of the positive and negative 6-year rolling skewness of exports (equation (6a)). As an additional test for such nonlinearities, we replace the quadratic terms by the interactions of the 6-year rolling kurtosis of exports with the positive and negative 6-year rolling skewness of exports (equation (6b)). Panel fixed effect, sys-GMM, and cross-section OLS firm-level estimations of the following equations are conducted:

$$Corrupt_{it} = \alpha_0\ [+\ \alpha_1.Corrupt_{it-1}]\ +\ \boldsymbol{\beta_{2a}.Positive\_skewness_{it}} + \boldsymbol{\beta_{2b}.Negative\_skewness_{it}} + \boldsymbol{\beta_{2c}.Positive\_skewness^2_{it}} + \boldsymbol{\beta_{2d}.Negative\_skewness^2_{it}} + \alpha_3.std\_dev_{it} + \alpha_4.Macro\_controls_{it}\ \{+\ \alpha_5.Micro\_controls_{it} + \alpha_6.timefixed\_controls\} + \lambda_t\ [+\ \mu_i] + \varepsilon_{it} \quad (6a)$$

and

$$Corrupt_{it} = \alpha_0\ [+\ \alpha_1.Corrupt_{it-1}]\ +\ \boldsymbol{\beta'_{2a}.Positive\_skewness_{it}} + \boldsymbol{\beta'_{2b}.Negative\_skewness_{it}} + \boldsymbol{\beta'_{2c}.Positive\_skew*6yr\_kurtosis_{it}} + \boldsymbol{\beta'_{2d}.Negative\_skew*6yr\_kurtosis_{it}} + \beta'_{2e}.6yr\_Kurtosis_{it} + \alpha_3.std\_dev_{it} + \alpha_4.Macro\_controls_{it}\ \{+\ \alpha_5.Micro\_controls_{it} + \alpha_6.timefixed\_controls\} + \lambda_t\ [+\ \mu_i] + \varepsilon_{it} \quad (6b)$$

Results are presented in table 3 and first stage estimates in annex C.3. FE estimates of equations (6a) and (6b) highlight a significant U-shaped *ex post* effect of export instability on corruption perceptions. Below a 6-year skewness of 150% and a 6-year kurtosis of 286%[11], we find a 1%-significant 'global deterrent' *ex post* effect of export instability on corruption perceptions. Above these threshold values, the sign of the relationship reverses and a 1% or 3%-significant 'global boosting' *ex post* effect of instability is evidenced. Sys-GMM estimates of equation (6a) also support the existence of an 11-15% significant U-shaped *ex post* effect of export instability on corruption, with a turning point corresponding to an absolute value of skewness of 125-150%.

OLS firm-level estimates of equations (6a) and (6b) with the original sample of firms are presented in left-sided uncoloured columns of table 3, while estimates obtained with the sample of "active" firms are presented in right-sided blue columns. Estimations of equation (6b) conducted on both

[11] A value of kurtosis surprisingly close to the kurtosis of a normal distribution (300%).

the whole sample and the sample of "active" firms support a similar U-shaped *ex post* effect of export instability on firms' corruption expenses. Estimation of equation (6b) conducted on the whole sample of firms supports a 15%-significant U-shaped effect of both positive and negative skewness of exports, with a kurtosis threshold of 220% and 226%, respectively. When the sample is restricted to "active" firms, estimates of equation (6b) support a 1%-significant U-shaped effect of both positive and negative skewness of exports, with a kurtosis threshold of 328% and 186%, respectively.

5.3. Disentangling the *ex ante* effects of instability: accounting for the "normal" or "abnormal" nature of export instability

Distinct effects of "normal" and "systemic" risk on insurance patterns have been underlined by Collier (2002), who points out the existence of a "paradox of insurance provision". Although insuring against systemic risk should be the desirable practice, it appears that the most common practice is the opposite pattern: small-size, frequent, idiosyncratic shocks are better insured than economy-wide, infrequent and large shocks. Considering that corruption activities can act as an insurance against income fluctuations when they are undertaken to secure future resource inflows, a positive relationship between perceptions of instability and resource-locking corrupt transactions should be empirically observed in case of "normal" or "humdrum" fluctuations; while a negative relationship should be observed in case of "abnormal" or "systemic" fluctuations.

Nonlinearities depending on the size and frequency of economic fluctuations may therefore characterize the *ex ante* effect of instability and corruption. We consider that the long-run kurtosis of the distribution of exports around their trend provides additional information on the way economic agents perceive instability. For a given 16-year standard deviation of exports, a low rolling 16-year kurtosis characterizes contexts where agents perceive economic instability as the result of "normal" fluctuations. By contrast, a high 16-year kurtosis of exports rather characterizes contexts where agents perceive instability as the result of "abnormal" fluctuations.

Table 3. Nonlinear *ex post* and *ex ante* effects of instability

Dependent variable:	**ICRG**								**WBES**					
	Within fixed effects			IV-2SLS	GMM-CUE	Sys-GMM			OLS					
Equations:	**(6a)**	**(6b)**	**(7)**	**(7)**		**(6a)**	**(6b)**	**(7)**	**(6a)**		**(6b)**		**(7)**	
Lagged Corruption	0.694***	0.692***	0.690***	0.674***	0.676***	0.742***	0.747***	0.721***						
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)						
Skew>0	-0.003***	-0.002***	-0.001*	-0.001**	-0.001**	-0.005**	-0.003†	-0.001*	-0.002	-0.027	-0.112†	-0.328***	-0.003	-0.003
	(0.00)	(0.00)	(0.06)	(0.03)	(0.03)	(0.03)	(0.14)	(0.09)	(0.94)	(0.33)	(0.14)	(0.00)	(0.30)	(0.43)
Skew<0	-0.003***	-0.002***	-0.0003	-0.0004	-0.0003	-0.003*	-0.002	-0.001	0.016	-0.017	-0.068*	-0.186***	-0.013**	-0.005
	(0.00)	(0.01)	(0.39)	(0.28)	(0.30)	(0.09)	(0.50)	(0.35)	(0.51)	(0.69)	(0.09)	(0.00)	(0.02)	(0.44)
$[\text{Skewness}>0]^2$	1e-05***					2e-05†			7e-06	0.0001				
	(0.00)					(0.11)			(0.96)	(0.32)				
$[\text{Skewness}<0]^2$	1e-05***					1e-05†			-0.0002	4e-05				
	(0.00)					(0.15)			(0.29)	(0.87)				
[Skew>0]*6Kurt		7e-06**					1e-05				0.0005†	0.001***		
		(0.02)					(0.24)				(0.13)	(0.00)		
[Skew<0]*6Kurt		7e-06**					8e-06				0.0003†	0.001***		
		(0.03)					(0.48)				(0.11)	(0.00)		
Export std_dev	-0.003	-0.003	0.020	0.127**	0.135***	-0.051	-0.039	0.007	0.884***	0.275	0.980***	0.602***	0.867***	0.299*
	(0.84)	(0.84)	(0.19)	(0.02)	(0.01)	(0.59)	(0.64)	(0.99)	(0.00)	(0.32)	(0.00)	(0.00)	(0.00)	(0.10)
Std_dev*16Kurt			-4e-05***	-2e-04***	-2e-04***			-5e-05					-0.0002	-0.0002
			(0.01)	(0.01)	(0.01)			(0.90)					(0.42)	(0.35)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs. (countries)	1144 (68)	1144 (68)	1144 (68)	1143 (67)	1143 (67)	1144 (68)	1144 (68)	1144 (68)	9212(23)	4283(23)	9212(23)	4283(23)	9212(23)	4283(23)
Hansen test (p-val)				0.67	0.67	0.85	0.35	0.75						
R-squared:				0.626	0.623	Wald (31) = 962	Wald (32) = 953	Wald (31) = 511	0.10	0.10	0.10	0.10	0.10	0.10
Within	0.645	0.644	0.643											
Between	0.931	0.964	0.842											
AR(1) test (p-val)						0.00	0.00	0.00						
AR(2) test (p-val)						0.28	0.33	0.58						
Number of instruments				4	4	56	51	44						

Controls not reported. When possible, coefficients are rounded to three decimal places. Standards errors robust to heteroskedasticity in all regressions and clustered by country in OLS firm-level estimations. P-values in parenthesis. †significant at 15% *significant at 10%; **significant at 5%; ***significant at 1%. 2SLS and GMM-CUE estimates are adjusted for small sample bias. **Sys-GMM estimation of equation (6a)**: The positive and negative skewness of exports, and the squared terms are treated as predetermined and instrument the differenced equation by their lagged levels (lags 1 to 6). Lagged corruption is treated as endogenous and instruments the equation in system by its lagged levels and differences (lags 2 to 8). The standard deviation of exports is treated as endogenous and instruments the differenced equation by its lagged levels (lags 2 to 6). **Sys-GMM estimation of equation (6b)**: The positive and negative skewness of exports, the 6-year kurtosis and the interaction terms are treated as predetermined, and instrument the differenced equation by their lagged levels (lags 1 to 4). Lagged corruption is treated as endogenous and instruments the equation in system by its lagged levels and differences (lags 2 to 6). The standard deviation is treated as endogenous and instruments the differenced equation by its lagged levels (lags 2 to 6). **Sys-GMM estimation of equation (7)**: The 16-year kurtosis of exports is an excluded instrument. The positive and negative skewness of exports, and the squared terms are treated as predetermined and instrument the differenced equation by their lagged levels (lags 1 to 6). Lagged corruption is treated as endogenous and instruments the equation in system by its lagged levels and differences (lags 2 to 8). The standard deviation of exports and the interaction term are treated as endogenous and instrument the differenced equation by their lagged levels (lags 2 to 5). In all sys-GMM estimations, time dummies are excluded instruments, instruments are collapsed, orthogonal deviations are preferred to first-difference deviations, and the Windmeijer correction of the two-step estimated variance is applied.

Therefore, we insert into the corruption equation the product of the 16-year rolling kurtosis of exports with the 16-year rolling standard deviation of exports:

$$Corrupt_{it} = \alpha_0 \,[+\ \alpha_1.Corrupt_{it-1}] + \alpha_{2a}.Positive\_skewness_{it} + \alpha_{2b}.Negative\_skewness_{it} + \boldsymbol{\beta_{3a}.\ std\_dev_{it}} + \boldsymbol{\beta_{3b}.std\_dev_{it}*16yr\_kurtosis} + \beta_{3c}.16yr\_Kurtosis_{it} + \alpha_4.Macro\_controls_{it} \{+\ \alpha_5.Micro\_controls_{it} + \alpha_6.timefixed\_controls\} + \lambda_t \,[+\ \mu_i] + \varepsilon_{it} \quad (7)$$

Results are presented in table 3. FE estimates of equation (7) show a significant kurtosis threshold equal to 400%, beyond which the statistical relationship between the 16-year standard deviation of exports and corruption becomes highly significant and negative. In other words, when perceptions of instability result from "abnormal" fluctuations corruption is found to decrease, which is consistent with the "paradox of insurance provision" previously mentioned.

To address the potential endogeneity bias in the relationship between the standard deviation of exports corruption in panel estimations[12], we instrument the standard deviation and the interaction term in equation (7) by our natural disaster variable, the 16-year standard deviation of rainfall, and the products of the 16-year export kurtosis with these two excluded regressors. First-stage estimations are hence conducted on the following system:

$$Std\_dev_{it} = \gamma_0 + \gamma_1.Corrupt_{it-1} + \boldsymbol{\gamma_2.Natural\_shocks_{it}} + \boldsymbol{\gamma_3.Natural\_shocks*16yr\_export\_kurtosis_{it}} + \gamma_4.16yr\_Kurtosis_{it} + \gamma_5.controls_{it} + o_t + \pi_i + \omega_{it} \quad (7a)$$

$$Std\_dev*16yr\_export\_kurtosis_{it} = \gamma'_0 + \gamma'_1.Corrupt_{it-1} + \boldsymbol{\gamma'_2.Natural\_shocks_{it}} + \boldsymbol{\gamma'_3.Natural\_shocks*16yr\_export\_kurtosis_{it}} + \gamma'_4.16yr\_Kurtosis_{it} + \gamma'_5.controls_{it} + o'_t + \pi'_i + \omega'_{it} \quad (7b)$$

where $Natural\_shocks_{it}$ is a vector including the natural disaster and the rainfall instability variables. 2SLS and GMM-CUE regressions are run on equations (7), (7a) and (7b). Second-stage results are presented in table 3, and first-stage results are presented in annex C.3.

2SLS and GMM-CUE estimations pass the Hansen test of over-identification restrictions, and do not seem to suffer from weak identification bias. Both estimations support a hump-shaped *ex ante* effect of export instability on corruption. Below a kurtosis threshold of 635% (2SLS) and 675% (GMM-CUE), a 1% significant positive *ex ante* effect of instability is found, while above these thresholds the direction of the effect reverses in a 1% confidence level. Thus, corruption is found to significantly increase when perceptions of export instability arise from "normal" fluctuations, while corruption is found to significantly decrease when perceptions of export instability arise from "abnormal" fluctuations. It could be rightly objected that very few observations exhibit a kurtosis exceeding 635%[13], which suggests that the hump-shaped relationship between the standard deviation of exports and corruption should be considered with caution. Nevertheless our results suggest that resource-locking corruption *ex ante* strategies are very likely to spread where and when perceptions of instability arise from "normal" fluctuations.

---

[12] As a reminder, the endogeneity test conducted on the standard deviation of exports alone rejects in a 14% confidence level the exogeneity assumption.

[13] 58 observations in 9 countries: Cuba (3), Denmark (9), Finland (3), Greece (8), Guyana (12), Indonesia (3), Madagascar (11), Mali (4), and Portugal (5)

6. The role of the liquidity constraint in channelling the effects of export instability on corruption

As a reminder, access to credit and insurance markets determines households' strategies for smoothing their consumption or income path (Paxson, 1992; Dercon, 2002). Notably, it has been argued that informal "risky" risk-coping and risk-managing strategies, such as prostitution (Robinson and Yeh (2011)) or crime (Guillaumont and Puech (2006)), may be adopted when financial markets do not enable agents to fully protect against fluctuations in their revenue. It is hence likely that corruption strategies are undertaken by liquidity-constrained agents to alleviating the adverse effects of income instability.

Moreover, by increasing or reducing the opportunity cost of engaging in illegal income-generating activities, access to lending may also determine the nature of the marginal *ex post* effect of income shocks on corrupt transactions (whether they are driven by survival or opportunistic motives). It can be indeed hypothesised that the 'global deterrent' *ex post* effect arising from the decreasing marginal effect of shocks on corruption holds in situations of *soft budget constraint*. On the contrary, it is plausible that the 'global boosting' *ex post* effect arising from the increasing marginal effect of shocks on corruption (see graph 4iv)) holds in situations of *hard budget constraint*.

Both of these reasons motivate an analysis of the role of agents' liquidity constraint in driving the *ex post* and *ex ante* effects of instability on corruption. We use the logarithm of the credit provided to the private sector in % of GDP (*credit_market*) as a proxy for formal financial markets access, and insert it as interaction term with the skewness and the standard deviation of exports in the corruption equation.

In equation (8a), we test whether financial market access is a key channel for the *ex post* effect of instability on corruption:

$$Corrupt_{it} = \alpha_0 \, [+ \, \alpha_1.Corrupt_{it-1}] + \boldsymbol{\rho_{2a}.Positive\_skewness_{it}} + \boldsymbol{\rho_{2b}.Negative\_skewness_{it}} + \boldsymbol{\rho_{2c}.Positive\_skew_{it}*credit\_market_{it}} + \boldsymbol{\rho_{2d}.Negative\_skew_{it}*credit\_market_{it}} + \rho_{2e}.credit\_market_{it} + \alpha_3.std\_dev_{it} + \alpha_{4b}.Macro\_controls_{it} \, \{+ \, \alpha_5.Micro\_controls_{it} + \alpha_6.timefixed\_controls\} + \lambda_t \, [+ \, \mu_i] + \varepsilon_{it} \quad (8a)$$

In equation (8a), we test whether financial market access is a key channel for the *ex ante* effect of instability on corruption:

$$Corrupt_{it} = \alpha_0 \, [+ \, \alpha_1.Corrupt_{it-1}] + \alpha_{2a}.Positive\_skewness_{it} + \alpha_{2b}.Negative\_skewness_{it} + \boldsymbol{\rho_{3a}.std\_dev_{it}} + \boldsymbol{\rho_{3b}.std\_dev_{it}*credit\_market_{it}} + \rho_{3b}.credit\_market_{it} + \alpha_{4b}.Macro\_controls_{it} \, \{+ \, \alpha_5.Micro\_controls_{it} + \alpha_6.timefixed\_controls\} + \lambda_t \, [+ \, \mu_i] + \varepsilon_{it} \quad (8b)$$

Fixed effect, sys-GMM panel estimates, and OLS firm-level estimates of equations (8a) and (8b) are presented in table 4.

6.1. Credit market as a channel for the *ex post* effects of instability

In regards to the *ex post* effects of instability (equation (8a)), FE estimates evidence a 'global deterrent' effect of instability on corruption when access to credit is improved. FE estimation of equation (8a) without time dummies (column (2)) suggests that above a respective 8.5% and 12.2%

credit threshold, episodes of positive and negative shocks are both found to deter corruption. Below this threshold, a 'global boosting' effect of instability on corruption level is evidenced, but not in the usual confidence level. Following our conceptual framework presented in section 2.1, FE estimations indicate that a softened (hardened) liquidity constraint is plausibly associated with a decreasing (increasing) marginal effect of export shocks on corruption. The liquidity constraint hence appears as a credible channel for the nonlinear *ex post* effect of instability evidenced in section 5 and depicted in section 2.

OLS firm-level estimates of equation (8a), conducted on the original sample of firms (column (8)), support the existence of a 5% credit threshold beyond which the relationship between the negative skewness of exports and firms' corruption expenses reverses and enters negative. Estimation of equation (8a) on the sample of 'active' firms (column (9)) provides significant evidence of a hump-shaped relationship between the negative skewness of exports and firms' informal payments, with a 5% significant turning point corresponding to a credit threshold of 20% of GDP. This evidence is consistent with FE estimates of equation (8a), which also show that the credit-channel is more significant during negative shocks than during positive shocks. Thus, estimations support that survival bribe payments are made to cope with adverse shocks, when access to lending is imperfect.

6.2. Credit markets as a channel for the *ex ante* effect of instability

FE country-level estimates of equation (8b), displayed in columns (3) and (4), highlight a hump-shaped relationship between the standard deviation of exports and firms' informal payments. In fact, the first-order condition of equation (8b) shows that a higher perception of export instability is significantly and positively associated with corruption when the share of credit provided to the private sector is below 24% of GDP, while it is significantly and negatively associated with corruption beyond this threshold. A similar hump-shaped relationship is evidenced in firm-level estimation of equation (8b), when the sample is restricted to "active" firms (column (11)). We observe that the effect of the standard deviation of exports on bribe payments is 1%-significant and positive below a credit threshold of around 60% of GDP; while it is 1%-significant and negative above it. As a consequence, access to credit markets also appears as a key channel for the *ex ante* effect of export instability on corruption.

Evidence on the role of financial markets in channelling the *ex post* and *ex ante* effects of export instability on corruption is striking and strongly supports that corruption may allow liquidity-constrained agents to cope with and insure against adverse shocks. We also stress that the liquidity constraint is likely to drive the nonlinear *ex post* effect of instability evidenced in section 5.

Table 4. The role of the liquidity constraint in channelling the *ex post* and *ex ante* effects of instability on corruption

Dependent variable:	**ICRG**						**WBES**			
	Within fixed effects				Sys-GMM		OLS			
Equations	**(8a)**		**(8b)**		**(8a)**	**(8b)**	**(8a)**		**(8b)**	
	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)	(10)	(11)
Corruption t- 1	0.691*** (0.00)	0.711*** (0.00)	0.685*** (0.00)	0.706*** (0.00)	0.733*** (0.00)	0.701*** (0.00)				
Export skew>0	0.001 (0.42)	0.001 (0.22)	-0.0005* (0.07)	-0.001*** (0.00)	-0.006 (0.36)	-0.001† (0.11)	-0.043 (0.17)	0.060 (0.40)	-0.004* (0.06)	0.003 (0.42)
Export skew<0	0.002 (0.26)	0.002† (0.11)	-0.0003 (0.44)	-0.0002 (0.57)	-0.007 (0.21)	-0.001† (0.13)	0.017 (0.41)	0.048** (0.04)	-0.014*** (0.01)	-0.015** (0.02)
Skew>0*credit access	-0.0004 (0.21)	-0.001* (0.06)			0.001 (0.45)		0.009 (0.25)	-0.016 (0.35)		
Skew<0*credit access	-0.0005 (0.19)	-0.001* (0.08)			0.002 (0.25)		-0.011* (0.08)	-0.016** (0.05)		
Export std_dev	-0.001 (0.93)	-0.001 (0.91)	0.050** (0.05)	0.057*** (0.00)	-0.005 (0.92)	-0.134 (0.62)	0.961*** (0.00)	0.110 (0.51)	1.223*** (0.00)	2.648*** (0.00)
Std_dev* credit access			-0.016* (0.07)	-0.018** (0.02)		0.066 (0.47)			-0.104 (0.38)	-0.647*** (0.00)
Credit to private sector	0.055 (0.34)	0.098† (0.11)	0.010† (0.11)	0.122** (0.03)	-0.212 (0.47)	-0.558 (0.37)	-0.272 (0.57)	-0.131 (0.91)	0.731** (0.03)	1.951*** (0.00)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Time dummies	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Obs (countries/cluster)	1130 (67)	1130 (67)	1130 (67)	1130 (67)	1130 (67)	1130 (67)	9212(23)	4283(23)	9212 (23)	4283(23)
R-squared:										
Within	0.895	0.606	0.647	0.649	Wald chi2(32)= 2143	Wald chi2(31) = 1037	0.10	0.10	0.10	0.11
Between	0.966	0.628	0.933	0.645						
Hansen test (p-val)					0.76	0.83				
AR(1) test (p-val)					0.00	0.00				
AR(2) test (p-val)					0.21	0.34				
Number of instruments					55	53				

Controls not reported. When possible, coefficients are rounded to three decimal places. Standards errors robust to heteroskedasticity in all regressions, and are clustered by country in OLS firm-level estimations. P-values in parenthesis. † significant at 15% *significant at 10%; **significant at 5%; ***significant at 1%. Hansen J-statistic tests for joint instrument validity; null hypothesis is that the instruments are valid, i.e., uncorrelated with the error term, and that the excluded instruments are correctly from the second-stage equation. **Sys-GMM estimation of equations (4.8a)**: The positive and negative skewness of exports are treated as predetermined and instrument the differenced equation by their lagged levels (lags 1 to 5). Lagged corruption and the interaction terms are treated as endogenous and instrument the equation in system by their lagged levels and differences (lags 2 to 7). The standard deviation of exports is treated as endogenous and instruments the differenced equation by its lagged levels (lags 2 to 6). **Sys-GMM estimation of equations (4.8b)**: Time dummies are excluded instruments. The positive and negative skewness of exports are treated as predetermined, and instrument the differenced equation by their lags 1 to 7. Lagged corruption is treated as endogenous and instrument the equation in system by its lagged levels and differences (lags 2 to 7). The standard deviation of exports is treated as endogenous and instrument the differenced equation by its lagged levels (lags 2 to 7). In all GMM estimations, time dummies are excluded instruments, instruments are collapsed, orthogonal deviations are preferred to first-difference deviations, and the Windmeijer correction of the two-step estimated variance is applied.

7. Idiosyncratic versus common export fluctuations

Following Dercon (2002), we check whether nonlinear relationships previously evidenced hold when we separate the effects of aggregate export fluctuations from those of idiosyncratic export fluctuations on firms' informal payments. To account for firms' individual experience and perception of export instability, we weight measures of skewness and standard deviation of exports by the share of direct and indirect exports[14] in firm's total sales:

$$Idiosyncratic\ instability = (instability\ measure) \times (\%\ of\ exports\ in\ total\ sales) \qquad (9)$$

We test the effects of idiosyncratic export fluctuations by inserting into equations (5), (6a), (6b), (7), (8a) and (8b) our measures of idiosyncratic instability. Previous indicators of aggregate export instability are maintained in the corruption equation to control for the separate effects of aggregate fluctuations. The resulting OLS estimates, presented in table 5, tell an interesting story.

First, estimated effects of aggregate instability indicators in column (1) are strikingly similar to those of equation (5) in table 2 (column (4)), suggesting that these previous estimations were merely reflecting the *ex ante* and *ex post* effects of common fluctuations on firms' bribe payments, not the joint effects of common and idiosyncratic fluctuations. Second, estimates of equation (5) (columns (1) and (2)) suggest that the 'global deterrent' *ex post* effect of instability evidenced in table 2 also holds for idiosyncratic fluctuations. By contrast, the *ex ante* effect of perceived instability holds for economy-wide exports fluctuations only, suggesting that i) resource-locking strategies act as a protection against common shocks, or ii) firms' perception of instability is more influenced by economy-wide fluctuations than individual ones.

7.1. Emphasising the size and frequency of idiosyncratic export fluctuations

In columns (3) to (8), evidence of an *ex ante* and *ex post* effects of idiosyncratic export instability nonlinear in the size and frequency of shocks cannot be established in the same confidence levels as for aggregate instability (see table 3). VIF statistics presented in annex D show that multicolinearity is present in equations (6a) and (7), and very worrying in equation (6b). This suggests that the statistical significance of the relationship tested in equation (6b) may be understated by inflated standard errors.

In spite of these inflated standard errors, estimates of equation (6a) in column (3) and (4) are highly consistent with FE and sys-GMM estimates in table 3. We indeed find significant evidence of a 'global deterrent' *ex post* effect of small and frequent idiosyncratic export fluctuations, and (less significant) evidence of a 'global boosting' *ex post* effect of large and infrequent idiosyncratic export fluctuations on firms' informal payments. However, there are no evidence of a nonlinear *ex ante* effect of

[14] Indirect exports are merchandizes and services sold domestically to exporter third party.

idiosyncratic export instability depending on normal/abnormal patterns of export fluctuations (columns (7) and (8) in table 5).

7.2. How liquidity-constrained firms respond to idiosyncratic export fluctuations

In columns (9) to (12), we emphasise the role of the liquidity constraint in channelling the *ex post* and *ex ante* effects of idiosyncratic instability. We use two proxies of firms' liquidity constraint. As done previously, we use the logarithm of the domestic credit provided to the private sector, as a country-level proxy for the ease with which firms accede to lending. We also use the share of the firms' working capital financed by internal funds or retained earnings (drawn from the WBES database) as a micro-level proxy for firms' actual cash position.[15] Estimates of equation (8a) are displayed in columns (9) and (10), and estimates of equation (8b) are displayed in columns (11) and (12).

Estimates of equation (8a) in column (9) support that an increase in the share of credit provided to the private sector dampens the positive effect of negative idiosyncratic shocks on firms' informal payments. In parallel, using the firm's share of working capital financed by internal funds as a proxy for its actual liquidity constraint (column 10), we find that, in a 9% confidence level, an improved cash position reduces the deterrent effect of episodes of positive idiosyncratic shocks on firms' informal payments. In other words, while an improved access to credit is found to mitigate the boosting effect of adverse idiosyncratic shocks on survival bribe payments, a favourable cash position is found to mitigate the deterrent effect of favourable idiosyncratic shocks on survival bribe payments.

Estimates of equation (8b) in column (11) do not support that access to lending is a significant channel for the *ex ante* effect of idiosyncratic instability on firms' informal payments. However, estimates of equation (8b) in column (12) show a significant negative *ex ante* effect of idiosyncratic instability on corruption when firms' cash position improves. Thus, while access to credit is found to mitigate the positive *ex ante* effects of aggregate instability on bribe payments (see table 4 columns (3), (4) and (11)), cash surplus is found to mitigate the positive *ex ante* effect of idiosyncratic instability on bribe payments.

[15] It is worth mentioning that estimates of the cash-surplus channel should be considered with caution given a plausible bi-directional relationship between firms' informal payments and cash position. As an illustration, a firm's cash surplus may feed corrupt networks, it may also stem from corrupt activities, or simply may incite public official to extort more money.

8. Concluding remarks

In this paper, we set a conceptual framework for an empirical analysis of the effects of export instability on corruption. We find robust, nonlinear but opposite *ex post* and *ex ante* effects of export instability on corruption, both depending on the frequency and size of export fluctuations. On the one hand, export instability is found to have a deterrent *ex post* effect on corruption when fluctuations are moderate and frequent, and a boosting *ex post* effect when fluctuations are large and infrequent. On the other hand, we find evidence of a strong, significant and robust boosting *ex ante* effect of instability on corruption when export instability is perceived as "normal" (resulting from moderate and frequent fluctuations). Evidence of a deterrent *ex ante* effect of perceptions of "abnormal" instability (resulting from large and infrequent fluctuations) is also found but should be taken with caution. Finally, we highlighted that the liquidity constraint is a key channel for the direction of both *ex post* and *ex ante* effects of instability on corruption: when it hardens export instability is found to increase corruption; while when it softens, export instability is found to decrease it.

Thus, by addressing the modalities by which export fluctuations affect corruption levels, this paper hopefully opens new rooms for anti-corruption policies. First, our findings point out the damaging institutional effects of export instability in fragile states, since corrupt strategies may spread as a substitute for imperfect financial markets and/or a low state resilience to external fluctuations. We provide an additional argument in support to the reinforcement of state capacity for mitigating the consequences of shocks and policies lowering country's exposure to them. Moreover, improving access to formal and informal financial markets should yield important anti-corruption outcomes, since the liquidity constraint appears in our estimations as a key determinant of the direction of the *ex post* and *ex ante* effects of export instability upon corrupt transactions. Finally, evidence of boosting *ex post* and *ex ante* effects of export instability on corruption strategies highlights the role played by external factors of economic stability, such as aid and remittances (Combes and Ebeke, 2011; Guillaumont, 2006), in improving the quality of governance.

Table 5. The effects of idiosyncratic and aggregate export fluctuations (controls not reported)

Dependent variable: WBES	Eq (5)		Eq(6a)		Eq(6b)		Eq(7)		Eq (8a)		Eq (8b)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Aggregate fluctuations												
Positive skewness	-0.003	-0.003	-0.003†	-0.003	0.002	0.003†	-0.002	-0.002	-0.003*	-0.003	-0.003†	-0.002
	(0.16)	(0.31)	(0.15)	(0.30)	(0.28)	(0.15)	(0.25)	(0.34)	(0.09)	(0.16)	(0.12)	(0.32)
Negative skewness	-0.012 **	-0.009***	-0.012**	-0.009***	-0.006	-0.003	-0.013***	-0.011***	-0.013***	-0.013***	-0.013***	-0.010***
	(0.02)	(0.00)	(0.02)	(0.00)	(0.24)	(0.29)	(0.01)	(0.00)	(0.01)	(0.02)	(0.01)	(0.00)
Std_dev	0.813***	0.814***	0.817***	0.819***	0.814***	0.823***	0.828***	0.830***	0.847***	0.824***	0.851***	0.912***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Idiosyncratic fluctuations												
Positive skew	-0.009*	-0.010**	-0.020**	-0.020**	-0.003	-0.005	-0.009*	-0.010**	-0.042	-0.012**	-0.009†	-0.010***
	(0.06)	(0.02)	(0.05)	(0.02)	(0.84)	(0.72)	(0.07)	(0.02)	(0.35)	(0.03)	(0.12)	(0.01)
Negative skew	-0.007*	-0.008**	-0.027*	-0.026*	-0.004	-0.004	-0.006*	-0.007*	0.015	-0.010†	-0.006	-0.008**
	(0.06)	(0.03)	(0.10)	(0.09)	(0.61)	(0.61)	(0.09)	(0.06)	(0.21)	(0.13)	(0.24)	(0.03)
Positive skew^2			0.0001	5e-05†								
			(0.19)	(0.15)								
Negative skew^2			0.0001	0.0001								
			(0.26)	(0.25)								
Positive skew * Kurtosis					2e-05	1e-05						
					(0.64)	(0.76)						
Negative skew * Kurtosis					-6e-06	1e-05						
					(0.87)	(0.72)						
Positive skew *credit									0.009			
									(0.44)			
Negative skew *credit									-0.007**			
									(0.05)			
Positive skew *intern funds										5e-05*		
										(0.09)		
Negative skew *intern funds										7e-05		
										(0.42)		
Export std_dev	-0.022	-0.001	-0.011	0.009	-0.041	-0.018	-0.051	-0.026	0.061	-0.044	-0.037	-0.001
	(0.83)	(0.99)	(0.91)	(0.93)	(0.72)	(0.87)	(0.64)	(0.80)	(0.72)	(0.68)	(0.79)	(0.99)
Export std_dev* Kurtosis							5e-05	3e-05				
							(0.95)	(0.87)				
Export std_dev*credit											0.001	
											(0.67)	
Export std_dev*intern funds												-0.001**
												(0.03)
Country fixed effects	No	No	No	No	No	No	No	No	No	No	No	No
Time dummies	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Observations (clusters)						9212(23)						
R-squared						0.10						

When possible, coefficients are rounded to three decimal places. Standards errors robust to heteroskedasticity in all regressions and clustered by country. P-values in parenthesis. † significant at 15% *significant at 10%; **significant at 5%; ***significant at 1%. The "Kurtosis" variable refers to the 6-year kurtosis of exports when it enters in interaction with the skewness of exports, while it refers to the 16-year kurtosis when it enters in interaction with the standard deviation of exports.

References

Acemoglu, D., Johnson, S., Robinson, J and Y. Thaicharoen (2003) "Institutional causes, macroeconomic symptoms: instability, crises and growth", *Journal of Monetary Economics*, Vol.50, No.1, pp.49-123.

Alderman, H. (1996) "Saving and economic shocks in rural Pakistan", *Journal of Development Economics*, Vol.51, No.2, pp.343-365.

Andvig, J. C., and K. O. Moene (1990) "How corruption may corrupt", *Journal of Economic Behaviour and Organization,* Vol.13, No.1, pp.63-76.

Arezki, R., and M. Brükner (2010) "Resource Windfalls and Emerging Market Sovereign Bond Spreads: The Role of Political Institutions", IMF working paper 10/179. Published in the *World Bank Economic Review* (2012), Vol.26, No.1, pp.78-99.

Arin, K.P., Chmelarova, V., Feess, E., and A. Wohlschlegel (2011) "Why are corrupt countries less successful in consolidating their budgets?", *Journal of Public Economics*, Vol.95, No.7-8, p.521-530.

Bardhan, P. (1997) "Corruption and Development: A Review of Issues", *Journal of Economic Literature*, Vol.35, No.3, pp.1320-1346.

Bevan, D., Collier, P. and J.W. Gunning (1993) "Trade shocks in developing countries, Consequences and policy responses", *European Economic Review*, Vol.37, No.2-3, pp.557-565.

Brückner, M., and A. Ciccone (2011) "Rain and the Democratic Window of Opportunity", *Econometrica*, Vol.79, No.3, pp.923-947.

Cariolle, J. (2012) "Measuring macroeconomic volatility : applications to export revenue data 1970-2005", Working Paper, Fondation pour les Etudes et Recherches sur le développement International (FERDI). Invitation to revise and resubmit to the *Journal of Economic Surveys* (with M.Goujon).

Cariolle, J. (2011) "The retrospective economic vulnerability index, 2010 update", Working Paper, Fondation pour les Etudes et Recherches sur le développement International (FERDI). Invitation to revise and resubmit to the *Journal of Policy Modeling*.

Clarke, G.R.G. (2011) "How Petty is Petty Corruption? Evidence from Firm Surveys in Africa", *World Development*, Vol.39, No.7, pp.1122-1132.

Collier, P. (2002) "The Macroeconomic Repercussions of Agricultural Shocks and their Implications for Insurance", Discussion Paper No.2002/46, UNU-WIDER.

Combes, J.L., and C. Ebeke (2011) "Remittances and Household Consumption Instability in Developing Countries", *World Development*, Vol.39, No.7, pp.1076-1089.

Dercon, S. (2002) "Income risk, coping strategies, and safety nets", *The World Bank Research Observer*, Vol.17, No.2, pp.141-166.

Easterly, W., Kremer, M., Pritchett, L and L.H. Summers (1993) "Good policy or good luck?: country growth performance and temporary shocks", *Journal of Monetary Economics* Vol.32, No.3, pp.459-483.

Elbers, C., Gunning, J.W., and B.H. Kinsey (2007) "Growth and Risk: Methodology and Micro Evidence", *World Bank Economic Review*, Vol.21, No.1, pp.1-20.

Galbraith, J.K., *The Great Clash 1929*. Mariner Books, Houghton Mifflin Company, New York, USA, 1997.

Gokcekus, O., and Y. Suzuki (2011) "Business cycle and corruption", *Economics Letters*, Vol.111, No.2, pp.138-140.

Grossman, G.M., and E. Helpman (1994) "Protection for Sale", *American Economic Review*, Vol.84, No.4, pp.833-850.

Guillaumont, P. (2010) "Assessing the Economic Vulnerability of Small Island Developing States and the Least Developed Countries", *Journal of Development Studies*, Vol.46, No.5, pp.828-854.

Guillaumont, P., *Caught in a trap: Identifying the Least Developed Countries*. Economica. 2009a.

Guillaumont, P. (2009b) "An Economic Vulnerability Index: Its design and Use for International Development Policy", *Oxford Development Studies*, Vol.37, No.3, pp.193-228.

Guillaumont, P. "Macroeconomic vulnerability in low income countries and aid responses", in Eds. Bourguignon, F., Pleskovic, B., and J. van der Gaag, *Securing Development in an Unstable World*, World Bank Conference on Development Economics (ABCDE), World Bank Publication, 2006.

Guillaumont, P., and C. Simonet (2011) "Designing an index of structural vulnerability to climate change", Working Paper No.8, Innovative Indicator Series, Fondation pour les études et recherches sur le développement international (FERDI), Clermont-Ferrand.

Guillaumont, P., and F. Puech (2006) "Macro-economic instability and crime", Document de travail E2006.02, série Etudes et Documents, Centre d'Etudes et de Recherches sur le Développement International, University of Auvergne.

Guriev, S. (2004) "Red tape and corruption", *Journal of Development Economics*, Vol.73, pp.489– 504.

Hansen, L., Heaton, J., and A. Yaron (1996) "Finite sample properties of some alternative GMM estimators", *Journal of Business and Economic Statistics*, Vol.14, No.3, pp.262–280.

Husted, B.W. (1999) "Wealth, Culture, and Corruption", *Journal of International Business Studies*, Vol.30, No.2, pp.339-360.

Isham, J., Woolcock, M., Pritchett, L. and G. Busby (2005) "The Varieties of Resource Experience: Natural Resource Export Structures and the Political Economy of Economic Growth", *World Bank Economic Review*, Vol.19, No.2, pp.141-174.

Jensen, N.M., Li, Q., and A. Rahman (2010) "Understanding corruption and firm responses in cross-national firm-level surveys", *Journal of International Business Studies*, Vol.41, pp.1481-1502.

Jones, B., and B. Olken (2010) "Climate Shocks and Exports", *American Economic Review: Papers & Proceedings*, Vol.100, No.2, pp.454-459.

Kaplan, S.D., and V. Pathania (2010) "What influences firms' perceptions?", *Journal of Comparative Economics*, Vol.38, pp.419-431.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A. and and R Vishny (1999) "The quality of the government", *The Journal of Law, Economics, and Organization*, Vol.15, No.1, pp.222-279.

Matsuura, K., and C. Willmott (2007) "Terrestrial air Temperature and Precipitation: 1900-2006 Gridded Monthly Time Series, Version 1.01", University of Delaware.

Mauro, P. (2004) "The persistence of corruption and slow economic growth", *IMF Staff Paper*, Vol.51, No.1, International Monetary Funds.

Mobarak, A. (2005) "Democracy, Instability, and Economic Development", *Review of Economics and Statistics*, Vol.87, No.2, pp.348-361.

Paxson, C.H. (1992) "Using Weather Variability To Estimate the Response of Savings to Transitory Income in Thailand", *American Economic Review*, Vol.82, No.1, pp.15-33.

van der Ploeg, F. (2011) "Natural Resources: Curse or Blessing?", *Journal of Economic Literature*, Vol.49, No.2, pp.366-420.

van der Ploeg, F. (2010) "Aggressive oil extraction and precautionary saving: coping with instability", *Journal of Public Economics*, Vol.94, No.5-6, pp.421-433.

Rancière, R., Tornell, A., and F. Westermann (2008) "Systemic crises and growth", *The Quarterly Journal of Economics*, Vol.123, No.1, pp.359-406.

Robertson, C.J., and A. Watson (2004) "Corruption and change: the impact of foreign direct investment", *Strategic Management Journal*, Vol.25, No.4, pp.385-396.

Robinson, J., and E. Yeh (2009) "Transactional Sex as a Response to Risk in Western Kenya", Policy Research Working Paper No.4857, the World Bank. Published in the *American Economic Journal: Applied Economics* (2011), Vol.3, No.1, pp.35-64.

Rodrik, D. (2000) "Participatory Politics, Social Cooperation, and Economic Stability", *American Economic Review*, Vol.90, No.2, pp.140-144.

Sala-i-Martin, X., Doppelhofer, G., and R.I. Miller (2004) "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach", *American Economic Review*, Vol.94, No.4, pp.813-835.

Stevenson, B. and J. Wolfers (2011) "Trust in Public Institutions over the Business Cycle", CESIFO Working Paper No.3389.

Tanzi, V. (1994) "Corruption, government activities, and markets", IMF Working Paper WP/98/63, International Monetary Fund.

Transparency International, *Global Corruption Barometer*, 2009.

Treisman; D. (2000) "The causes of corruption: a cross-national study", *Journal of Public Economics*, Vol.76, pp.399–457.

Voors, M.J., Bulte, E.H., and R. Damania (2011) "Income Shocks and Corruption in Africa: Does a Virtuous Cycle Exist?", *Journal of African Economies*, Vol.20, No.3, pp395-418.

Annexes A – descriptive statistics

Annex A.1. country-level panel data.

country	Obs	country	Obs	country	Obs
Algeria	19	France	19	Norway	19
Argentina	19	Gabon	19	Pakistan	19
Australia	14	Greece	19	Papua New Guinea	17
Austria	19	Guatemala	19	Paraguay	19
Bangladesh	19	Guyana	11	Peru	19
Belgium	19	Honduras	19	Philippines	19
Bolivia	9	Hungary	19	Portugal	19
Botswana	4	India	19	Senegal	19
Brazil	19	Indonesia	19	South Africa	19
Burkina Faso	14	Ireland	19	Spain	19
Cameroon	19	Italy	19	Sudan	19
Canada	19	Japan	19	Sweden	19
Chile	19	Jordan	3	Syria	4
China	1	Kenya	19	Thailand	19
Colombia	5	Madagascar	19	Togo	19
Costa Rica	19	Malawi	19	Trinidad and Tobago	16
Cuba	9	Malaysia	19	Tunisia	18
Cyprus	4	Mali	12	United Kingdom	19
Denmark	19	Mexico	19	United States	9
Dominican Republic	19	Morocco	19	Uruguay	19
Ecuador	19	Netherlands	19	Zambia	19
El Salvador	19	New Zealand	19	Zimbabwe	3
Finland	19	Nicaragua	19		

East Asia and Pacific = 13% of total sample
Europe and Central Asia = 1,7% of total sample (Hungary)
Latin America and Caribbean = 28,2% of total sample
Middle East and North Africa = 9% of total sample
North America = 2,5% of total sample (Canada, USA)
South Asia = 5% of total sample (India, Bangladesh, Pakistan)
Sub Saharan Africa = 19,9% of total sample
Western Europe = 20,7% of total sample

Annex A.2 Firm-level cross section data.

country	Obs	country	Obs	country	Obs
Argentina	794 (8%)	Gabon	13 (0.1%)	Mexico	87 (1%)
Bolivia	302 (3%)	Guatemala	556 (6%)	Nicaragua	319 (3%)
Botswana	235 (2%)	Honduras	321 (3%)	Panama	31 (0.3%)
Chile	970 (10%)	Indonesia	1,152 (12%)	Paraguay	254 (3%)
Colombia	836 (9%)	Lesotho	12 (0.1%)	Peru	828 (9%)
Costa Rica	35 (0.4%)	Madagascar	63 (1%)	Philippines	1,115 (12%)
Dom. Republic	318 (3%)	Malawi	122 (1.32%)	Uruguay	512 (6%)
Ecuador	330 (4%)	Mauritius	7 (0.1%)		
East Asia and Pacific = 25% of total sample					
Latin America and Caribbean = 70% of total sample					
Sub Saharan Africa = 5% of total sample					

Annex A.3. Summary statistics of panel data

	Source	Obs	Mean	Std. Dev.	Min	Max
Dependent variable						
ICRG	PRS group	1144	2.61014	1.431315	0	6
Instability variables						
Export 16-year std dev	World Development Indicators 2010	1144	6.995185	3.620236	1.899827	20.58558
Export 6-year skewness		1144	18.36777	124.2091	-242.9317	242.9239
Export 6-year skewness > 0		1144	66.80871	69.34003	0	242.9239
Export 6-year skewness < 0		1144	48.44095	64.35557	0	242.9317
Export 6-year kurtosis		1144	233.2955	83.85703	109.9743	593.4952
Export 16-year kurtosis		1144	319.7907	166.7265	146.7546	1386.653
Rainfall 16-year std dev	Maatsura and Willmott (2007)	1144	12.81215	5.239885	2.756109	29.84307
Rainfall 6-year skewness		1144	-32.14799	106.1514	-204.6579	230.3528
People affected by natural disaster	EM-DAT (2012)	1144	1.275625	2.295293	0	20.65531
Export concentration	CERDI	775	27.08626	20.96736	0	91.88235
Controls						
Population growth (in %)	WDI 2010	1144	1.49221	.991445	-.6979211	6.047563
Log population		1144	16.56923	1.372346	13.52666	20.98849
Log credit to private sector (in %)		1130	3.544881	0.964273	0	5.442772
Natural resources (% of GDP)	World Bank	1144	5.203671	8.15379	0	59
Political regime stability	Polity IV	1144	29.46416	33.17404	0	196
Democracy		1144	5.369755	5.858688	-9	10
Govt expenditures (% of GDP)	Penn World Tables 2010	1144	15.69565	5.862845	4.652345	53.25081
Log openness (const. LCU)		1144	4.031649	.5520936	2.396314	5.35706

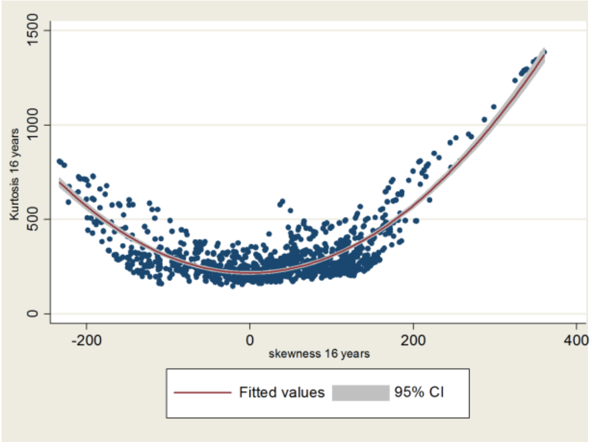
Annex A.4. Summary statistics of firm-level data

	Source	Obs	Mean	Std. Dev.	Min	Max
Dependent variable						
% of annual sales paid as informal payments	WBES 2008 – 2011	9212	0.7733391	4.090082	0	100
Instability variables (in % of the trend)						
Export 16-year std dev	World Development Indicators 2010	23	6.340868	2.396597	2.551279	12.998
Export 6-year skewness		23	63.55887	76.90412	-179.9973	166.0257
Export 6-year skewness > 0		23	76.55234	49.78118	0	166.0257
Export 6-year skewness < 0		23	12.99347	38.03289	0	179.9973
Export 6-year kurtosis		23	189.6478	47.9019	116.4359	416.3812
Export 16-year kurtosis		23	363.3209	180.9741	185.497	739.2167
Rainfall 16-year std dev 2008	Maatsura and Willmott (2007)	23	12.57644	4.866297	5.373374	22.89103
Rainfall 6-year skewness 2008		23	18.86488	121.7952	-178.599	182.2015
Rainfall 6-year skewness 2004		23	56.85211	111.7317	-196.032	173.3912
People affected by natural disaster 2005	EM-DAT (2012)	23	1.26377	1.335354	0.035672	7.292787
Macro – controls						
Gov expenditures (cst USD2000)	WDI 2010	23	1.36e+10	1.42e+10	3.82e+08	6.74e+10
Trade (in % of GDP)		23	69.83776	22.65299	38.29338	170.9021
Population growth (in %)		23	1.385411	0.5141451	.3047784	2.77755
Log population		23	17.08152	1.272961	14.05363	19.24198
Log GDP per cap t – 20		23	7.36509	0.81249	4.89926	8.762737
Log credit to private sector		23	3.410941	0.5103423	2.146021	4.57458
Natural resources (% of GDP)	World Bank	23	10.02095	9.668229	0	57
Political regime stability	Polity IV	23	20.49989	12.93696	6	89
Democracy		23	8.175423	1.212451	-4	10
Common law	La Porta et al. (1999)	23	0.0400564	0.1961023	0	1
Latitude		23	-7.94213	19.16726	-36.676	18.561
Landlockness		23	0.1004125	0.3005655	0	1
Firm's characteristics						
Size (1: small; 2:medium; 3:large)	WBES 2008-2011	9212	1.871581	0.7907208	1	3
State/govt ownership (% of firm)		9212	0.161637	2.93871	0	90
Direct exports (%of firm's sales)		9212	8.128745	22.52709	0	100
Indirect exports (%of firm's sales)		9212	3.050369	13.97412	0	100
% of working capital financed by internal funds		9212	61.99436	38.17022	0	100

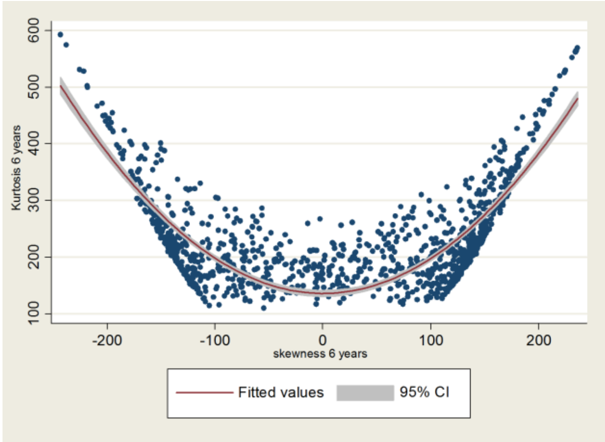
Annexes B – Additional insights into volatility measures

Annex B.1. Correlations between export skewness and export kurtosis.

16-years skewness versus 16-year kurtosis

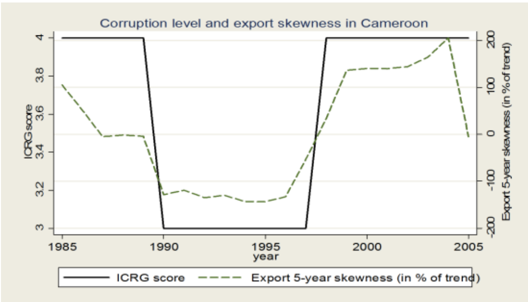


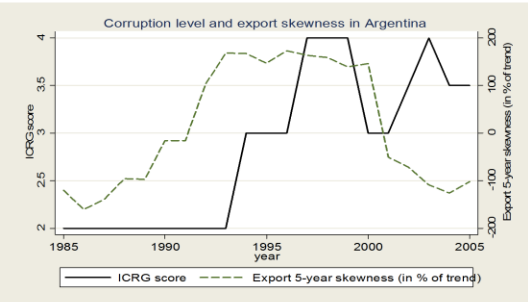
6-years skewness versus 6-year kurtosis



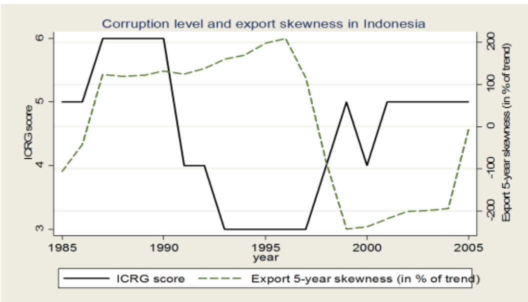
Annex B.2. Export skewness and corruption changes

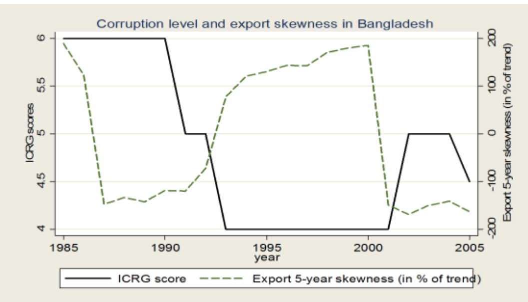
Pro-cyclical relationship (Cameroon, Argentina)





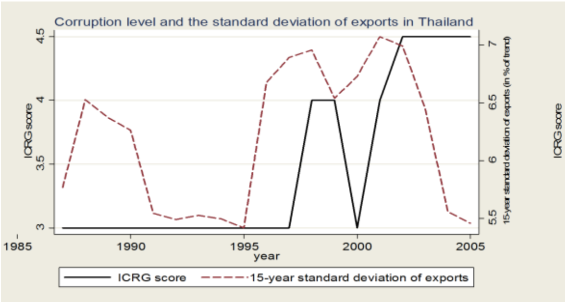
Contra-cyclical relationship (Indonesia, Bengladesh)



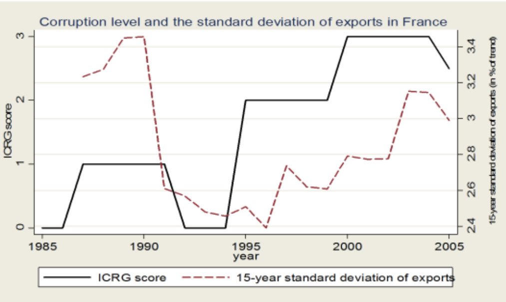


Annex B.3. the standard deviation of exports and corruption changes

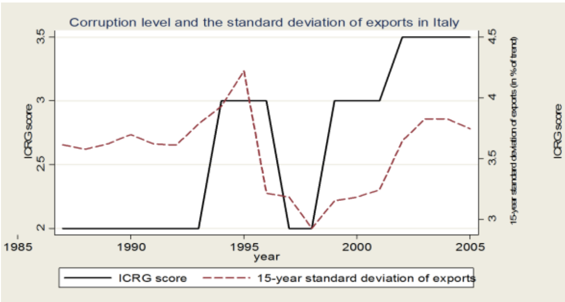
Thailand



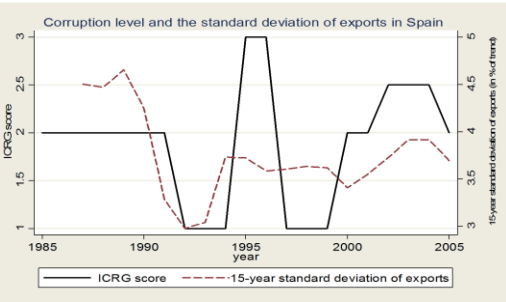
France



Italy



Spain



Annex C. Instrumental variable and GMM estimations: instruments and first stage estimates.

Annex C.1. Instruments description

Annual share of people (total) affected by natural disasters in the population.

We compute each year the ratio between the yearly-averaged number of total affected by natural disasters (gathered from the Emergency Disaster Database[16]) and the national population, which consists in applying the following formula:

$$Annual\ \%\ of\ people\ affected_t = 100 \times \frac{\frac{\sum_{t=1}^{T} Total\ affected}{T}}{Population_t}$$

Total affected is the sum of injured, homeless, and people requiring immediate assistance during the period of emergency following a natural disaster. It can also include displaced or evacuated people. Further detailed on the database is provided at http://www.emdat.be/criteria-and-definition.

6-year skewness of rainfall levels

This is the 6-year rolling skewness of the distribution of rainfall levels (r_{it}) around their average value (R_{it}). We compute it in country i at time t as follow:

$$Skew\_rainfall_{it} = 100 \times \frac{\frac{1}{T}\sum^{T}\left(\frac{r_{it}-R_{it}}{R_{it}}\right)^3}{\left(\frac{1}{T}\sum^{T}\left(\frac{r_{it}-R_{it}}{R_{it}}\right)^2\right)^{3/2}} \quad with\ T=[t\,;t-5]$$

16-year standard deviation of rainfall levels

This is the 16-year rolling standard deviation of the distribution of rainfall levels (r_{it}) around their average value (R_{it}). We compute this measure in country i at time t as follow:

$$Stddev\_rainfall_{it} = 100 \times \sqrt{\frac{1}{T}\sum^{T}\left(\frac{r_{it}-R_{it}}{R_{it}}\right)^2} \quad with\ T=[t\,;t-15]$$

The export concentration index

This variable is drawn from the retrospective EVI database available on the FERDI website (http://www.ferdi.fr/uploads/sfCmsContent/html/105/BDDinstabilities_exportations_finale.xlsx). The export concentration index is derived from the Herfindhal index applied to export of merchandises (excluding services) as categorized by the three-digit level of the Standard International Trade Classification (SITC). This index is between 0 and 1, a high level of concentration being associated with a score close to 1. A country exporting only one product would score 1 according to this index. The derived Herfindhal Index formula is the following:

[16] Data compiled by the Center for Research on the Epidemiology of Disaster (CRED) at the School of Public Health, Université Catholique De Louvain.

$$H_j = \frac{\sqrt{\sum_{i=1}^{n}\left(\frac{x_i}{X_j}\right)^2} - \sqrt{1/n}}{1 - \sqrt{1/n}}$$

Where j is the country index, xi is the value of exports of commodity I, Xj the total exports of country j, and n the number of products at the three-digit SITC level. The resulting data is then normalized using the min-max procedure with the bounds specified below.

Boundaries used for normalization.

Variables/components	Lower boundary	Upper boundary
Export concentration	0.100	0.950

Annex C.2 – Instability and corruption: Instrumental variable estimations of equation (4) – second and first stage estimates (included instruments not reported).

	ICRG		WBES			
				"Active" firms		"Passive" firms
2nd stage estimates	**2SLS**	**GMM-CUE**	**2SLS**		**GMM-CUE**	**2SLS**
Lagged Corruption	0.677*** (0.00)	0.706*** (0.00)				
Export skewness	-0.001 (0.24)	-0.001* (0.08)	0.002 (0.16)	0.003* (0.07)	0.004*** (0.00)	0.004*** (0.00)
Export std_dev	-0.051 (0.18)	-0.081* (0.06)	0.560*** (0.00)	0.230* (0.09)	0.361*** (0.00)	0.495*** (0.01)
1st stage estimates (a): export skewness						
Lagged Corruption	-5.82 (0.43)	-5.82 (0.43)				
Annual share of affected (% pop) (t)	-16.06*** (0.00)	-16.06*** (0.00)				
Annual share of affected (% pop) (t-3)			-31.34*** (0.01)	-33.05*** (0.00)	-33.05*** (0.00)	-28.71** (0.05)
Annual share of affected (% pop) (t-4)	13.59*** (0.00)	13.59*** (0.00)				
Export concentration index	0.609 (0.21)	0.609 (0.21)				
5-yr skewness of rainfall (t)	-0.037 (0.40)	-0.037 (0.40)	-0.158 (0.51)	0.126 (0.64)	0.126 (0.64)	-0.139 (0.53)
5-yr skewness of rainfall (t-4)	0.043 (0.38)	0.043 (0.38)	0.362 (0.22)	0.372 (0.24)	0.372 (0.24)	0.424* (0.09)
15- year standard deviation of rainfall	-4.538** (0.04)	-4.538** (0.04)	13.21*** (0.01)	12.33** (0.04)	12.33** (0.04)	12.81*** (0.00)
F(5,514)	6.44	6.44	8.42	5.86	5.86	15.35
Shea partial R2	0.04	0.04	0.44	0.42	0.42	0.47
1st stage estimates (b): export std_dev						
Lagged Corruption	0.129 (0.11)	0.129 (0.11)				
Annual share of affected (% pop) (t)	0.393*** (0.00)	0.393*** (0.00)				
Annual share of affected (% pop) (t-3)			0.093 (0.64)	-0.020 (0.92)	-0.020 (0.92)	0.242* (0.09)
Annual share of affected (% pop) (t-4)	0.039 (0.44)	0.039 (0.44)				
Export concentration index	0.021*** (0.01)	0.021*** (0.01)				
5-yr skewness of rainfall (t)	0.002*** (0.00)	0.002*** (0.00)	-0.014*** (0.00)	-0.015*** (0.00)	-0.015*** (0.00)	-0.013*** (0.00)

5-yr skewness of rainfall (t-4)	0.001*** (0.00)	0.001*** (0.00)	0.009** (0.02)	0.012*** (0.01)	0.012*** (0.01)	0.006** (0.02)
15- year standard deviation of rainfall	0.050** (0.04)	0.050** (0.04)	0.168*** (0.01)	0.156*** (0.01)	0.156*** (0.01)	0.200*** (0.00)
F(5,514)	6.97	6.97	12.25	9.23	9.23	16.42
Shea partial R2	0.12	0.12	0.57	0.62	0.62	0.61
Weak instrument test						
Kleibergen-Paap stat(critical value)	4.7 (21.7) [a]	4.7 (4.1) [a]	1.24(16.9)[a]	5.18 (16.9)[a]	5.18 (4.72)[a]	0.20(9.9)[a]
Hansen test (p-val)	0.17	0.21	**0.04**	0.45	0.50	**0.04**
Endogeneity test, Chi2 p-value:						
6-yr skew + 16-year std-dev exports	0.04					
6-year export skewness	0.25					
16-year std dev of exports	0.03					
Country fixed effects	Yes	Yes	No	No	No	No
Time dummies	Yes	No	No	No	No	No
Observations (countries or clusters)	700 (46)	700 (46)	9212(23)	4210 (23)	4210 (23)	3387(23)
R squared			0.02	0.02	0.02	0.03
Number of instruments	5	5	4	4	4	4

When possible, coefficients are rounded to three decimal places. Included instruments not reported. Standards errors robust to heteroskedasticity in all regressions, to autocorrelation in GMM-CUE estimations, and are clustered by country in OLS firm-level estimations. P-values in parenthesis. *significant at 10%; **significant at 5%; ***significant at 1% † significant at 14%. Hansen J-statistic tests for joint instrument validity; null hypothesis is that the instruments are valid, i.e., uncorrelated with the error term, and that the excluded instruments are correctly from the second-stage equation. In columns “active firms”, we restrict the sample to firms considering that corruption is not an obstacle or is a minor obstacle to their current operations. In column “passive firms”, we restrict the sample to firms considering that corruption is a moderate, major, and very severe obstacle to their current operations.

a.When the Kleibergen-Paap statistic exceeds the Stock-Yogo critical value, then a standard significance test on estimated coefficient with nominal size of 5% has a maximal size of 10% or more.

Annex C.3. Instability and corruption: Instrumental variable estimations of equation (7) – first stage estimates of equations (7a) and (7b) (included instruments not reported).

	ICRG	
2nd stage estimates	**IV-2SLS**	**GMM-CUE**
Lagged Corruption	0.674*** (0.00)	0.676*** (0.00)
Skewness>0	-0.001** (0.03)	-0.001** (0.03)
Skewness<0	-0.0004 (0.28)	-0.0004 (0.30)
Export std_dev	0.127** (0.02)	0.135** (0.02)
Export std_dev*16-year kurtosis	-0.0002*** (0.01)	-0.0002*** (0.01)
1st stage estimates (a): export std_dev		
Lagged Corruption	0.105* (0.07)	0.105* (0.07)
Annual share of homeless	0.171* (0.07)	0.171* (0.07)
16-year standard deviation of rainfall	0.008 (0.81)	0.008 (0.81)
Annual share of homeless*16-year kurtosis	0.0005** (0.04)	0.0005** (0.04)
16-year standard deviation of rainfall*16-year kurtosis	0.0001 (0.46)	0.0001 (0.46)
F(5,514)	11.19	11.19
Shea partial R2	0.06	0.06
1st stage estimates (b): export std_dev*16-year kurtosis		
Lagged Corruption	1.670 (0.96)	1.670 (0.96)
Annual share of homeless	-91.54 (0.23)	-91.54 (0.23)
16-year standard deviation of rainfall	76.02** (0.03)	76.02** (0.03)
Annual share of homeless*16-year kurtosis	0.726* (0.07)	0.726* (0.07)
16-year standard deviation of rainfall*16-year kurtosis	-0.181† (0.11)	-0.181† (0.11)
F(5,514)	7.89	7.89
Shea partial R2	0.08	0.08
Kleibergen-Paap stat(critical value)	10.8 (11) [a]	10.8 (4.7) [a]
Country fixed effects	Yes	Yes
Time dummies	Yes	Yes
Observations (countries or clusters)	1143 (67)	1143 (67)
R squared	0.626	0.623
Number of instruments	4	4

When possible, coefficients are rounded to two or three decimal places. Included instruments not reported. Standards errors robust to heteroskedasticity (2SLS; GMM-CUE) and autocorrelation (GMM-CUE). P-values in parenthesis. *significant at 10%; **significant at 5%; ***significant at 1% † significant at 14%.

Annex D. Variance inflation Factors (VIF) for the independent variables, table 5.

Variable	VIF	1/VIF
Equation (6a) without time dummies		
Positive skewness	6.49	0.154197
Negative skewness	4.96	0.201716
Idiosyncratic positive skew	30.91	0.032348
Idiosyncratic negative skew	17.93	0.055769
Idiosyncratic positive skew^2	11.77	0.084951
Idiosyncratic negative skew^2	14.10	0.070910
Std_dev	24.31	0.041135
Idiosyncratic std_dev	14.68	0.068117
Mean VIF	**14.93**	
Equation (6b) without time dummies		
Positive skewness	14.85	0.065362
Negative skewness	11.07	0.089086
Idiosyncratic positive skew	23.82	0.003971
Idiosyncratic negative skew	23.17	0.027550
Idiosync positive skew * idiosync. Kurtosis	18.58	0.004011
Idiosync negative skew * idiosync Kurtosis	20.68	0.020283
Std_dev	24.48	0.040583
Idiosyncratic std_dev	17.58	0.057971
Kurtosis	8.86	0.109476
Mean VIF	**20.06**	
Equation (7) without time dummies		
Positive skewness	6.58	0.151920
Negative skewness	5.11	0.195760
Idiosyncratic positive skew	7.68	0.129635
Idiosyncratic negative skew	1.90	0.527480
Std_dev	24.37	0.041023
Idiosyncratic std_dev	40.69	0.020563
Idiosyncratic std_dev*idiosync. Kurtosis	22.05	0.015996
Kurtosis	3.55	0.279813
Mean VIF	**14.64**	

Créée en 2003, la **Fondation pour les études et recherches sur le développement international** vise à favoriser la compréhension du développement économique international et des politiques qui l'influencent.

Contact
www.ferdi.fr
contact@ferdi.fr
+33 (0)4 73 17 75 30