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## Forms of government decentralization and institutional quality: Evidence from a large sample of nations

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**ADB Working Paper Series**

**Forms of Government Decentralization and  
Institutional Quality:  
Evidence from a Large Sample of Nations**

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**Abstract**

This paper studies the effects of various forms of government decentralization on institutional quality across countries. Using corruption and the shadow economy to proxy for institutional quality, as well as three forms of government decentralization (i.e., virtual, physical, and fiscal), the econometric results show virtual decentralization to be the most effective in improving institutional quality. The effects on transition and countries in Asia are also considered.

**JEL Classification:** K42; H11; H73

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## 1. INTRODUCTION

The decentralization of government functions can improve institutional quality and government performance (Besley and Coate 2003, Brueckner 2003, Prud'homme 1995, Rodriguez-Pose and Gill 2003, and World Bank 1999). Over time, the manners in which governments provide services to their populations have changed due to administrative capacities and technology; the physical and fiscal traditional forms of government decentralization (Lynch 1989) have evolved to include virtual. Physical decentralization involves creating subnational branches or tiers of government, fiscal decentralization deals with greater subnational control over tax collection and government spending (Yeung 2009), and virtual decentralization uses the internet to provide information and access to various government services (e.g., health advice, tax filings, passport applications, and business registration) to populations.

This study examines the effects of government decentralization on institutional quality in a large sample of countries. Corruption and the shadow economy are used to proxy for institutional quality, and virtual, physical, and fiscal decentralization represent the various forms of government decentralization. Corruption and the underground economy are two widely recognized illegal activities that impact the effectiveness of government policies.<sup>1</sup> A greater prevalence of corruption and/or the underground sector undermines government control over policies and their enforcement, signifying a diminished state of institutional quality.

## 2. THEORETICAL BACKGROUND AND RELEVANT LITERATURE

Among the three dimensions of government decentralization considered, fiscal decentralization seems to have garnered the most interest in the literature.<sup>2</sup> This may be due to the greater ease and practicality of assigning government spending to the local level and to quantifying such endeavors. Physical decentralization, also common, is difficult to alter in the short term, as changes in levels of government often entail lengthy legislative and administrative processes (Goel and Nelson 2011). Virtual decentralization is new; given the recent advent of the internet and digital divide across countries, policy makers are just beginning to implement government services in cyberspace. For researchers, quantifiable measures of such actions are only beginning to become available; thus, this study focuses on virtual decentralization.

Government decentralization influences the quality and delivery of government functions, which can impact illegal activities, including corruption and the underground economy.<sup>3</sup> The effects of various forms of decentralization on corruption and the shadow economy differ, however. For instance, physical decentralization can provide better communication between government bureaucrats and the public than virtual decentralization. Regarding corruption, greater proximity between bureaucrats and the public may promote greater transparency—or make forming corrupt relationships easier. Fiscal decentralization may make rent seeking easier at the local level, yet also

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<sup>1</sup> Note that institutions may be measured along numerous dimensions and that quantifying them is often difficult. See Knack and Keefer (1995) and Voigt (2013).

<sup>2</sup> See Adams, Delis, and Kammas (2014); Ebel and Yilmaz (2003); Fisman and Gatti (2002); Kyriacou and Roca-Sagalés (2011); de Mello and Barenstein (2001); Oto-Peralias, Romero-Ávila, Usabiaga (2013); Treisman (2006); and Yeung (2009).

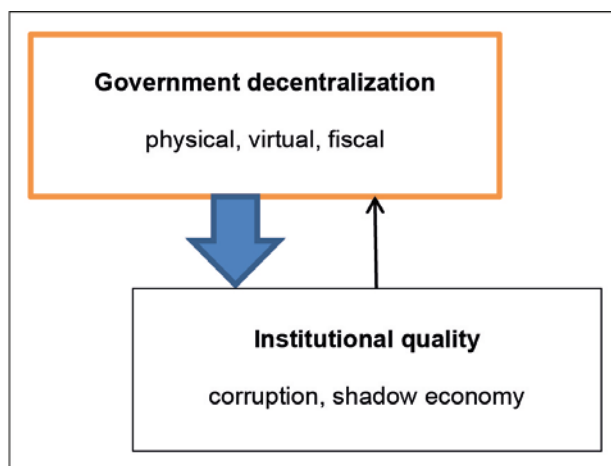
<sup>3</sup> The demerits of decentralization have been recognized by Prud'homme (1995).

be coupled with the threat of greater transparency and exposure (Arikan 2004). With respect to the underground economy, the transparency associated with physical decentralization can enable better monitoring of shadow activities (Bram 2013). However, physical decentralization may also make government officials more aware of potential shadow activities in which they can engage; this incentive could also be mitigated by virtual decentralization. Fiscal decentralization may affect the shadow economy by making it easier to outsource some government functions to the informal sector.

Overall, it is unclear whether all types of government decentralization yield similar dividends in terms of reducing illegal activities and improving institutional quality. The effects of decentralization on corruption have been widely studied,<sup>4</sup> but the literature on the linkage between decentralization and the shadow economy is somewhat more modest.<sup>5</sup> Corruption and the shadow economy are widely prevalent across the world<sup>6</sup> and have been used as indicators of institutional quality (Knack and Keefer 1995). However, the effects of virtual decentralization on corruption and the shadow economy are largely unclear.<sup>7</sup>

Unlike corruption, the involvement of government officials in shadow activities is indirect. Private parties engage in shadow operations (either directly or via outsourcing) to skirt regulations or to avoid taxes. There are several potential channels of influence of decentralization on the underground sector. For instance, greater decentralization, especially via e-government, lowers costs of obtaining information, encouraging compliance with laws. Further, government presence on line may act as a deterrent to certain shadow operations online (Bram 2013). E-government may also allow for “yardstick” competition as suggested by Besely and Case (1995), allowing voters to easily access information on taxes and spending in neighboring countries or within federal systems. This enhanced transparency may reduce the underground economy by raising tax morale (Torgler and Schneider 2009).

**Figure 1: Government Decentralization and Institutional Quality**



<sup>4</sup> See, for example, Bardhan and Mookherjee (2006), Fisman and Gatti (2002), and Goel and Nelson (2011).

<sup>5</sup> See, for example, Buehn, Lessmann, and Markwardt (2013), Goel and Saunoris (Forthcoming), and Teobaldelli (2011).

<sup>6</sup> See Schneider and Enste (2000), Tanzi (1982), and Transparency International. <http://www.transparency.org>.

<sup>7</sup> See Andersen (2009), Elgin (2013) and Kim (2014) for some exceptions.

All of these theoretical considerations form the foundation of this analysis that is primarily focused on assessing the relative impacts of different decentralization modes on institutional quality. The main hypothesis of this study is that greater decentralization of government structure, powers, and services improves institutional quality by lowering corruption and underground activities, although the type of decentralization may matter.

### 3. DATA AND EMPIRICAL ESTIMATION

#### 3.1 Data

The annual data used in this study are a cross section of over 120 countries. Variable definitions and sources are in Table A1. The main sources of these data are well known and widely used in the literature. The main variables of interest include measures of the shadow economy, corruption, and forms of government decentralization. It is important to note that both corruption and the shadow economy are illegal activities; thus, information on their prevalence is not readily forthcoming.

To instill confidence in the findings, two measures of each are used. First, with regard to the underground sector, Alm and Embaye (2013) used the currency demand approach to estimate its size (*Shadow1*), the main idea being that cash transactions are harder to trace, so shadow operations involve a greater demand for cash. The average size of the shadow economy with the *Shadow1* measure in the sample is 31% of gross domestic product (GDP) with considerable variation across countries. For instance, the Democratic Republic of the Congo has the largest shadow economy at 59%, whereas Switzerland has the smallest shadow economy at just over 11%.

A somewhat broader measure, used by Schneider, Buehn, and Montenegro (2010), is also employed, known as *Shadow2*.<sup>8</sup> They employed a specific type of structural equation model, the multiple indicators, multiple causes (MIMIC) model, to estimate the latent shadow economy variable (*Shadow2*). They used covariance information from observable variables classified as either “causes” or “indicators” of the shadow economy. Thus, while *Shadow1* focuses on only one indicator of the shadow economy (i.e., currency), *Shadow2* is a more comprehensive measure. The correlation between these two measures, *Shadow1* and *Shadow2*, of the shadow economy is 0.79 (Table A2).

Corruption is the other measure of institutional quality (Knack and Keefer 1995). Again, two measures are employed. *Corruption1* is an index of cross-national corruption from 0 to 6 from the International Country Risk Guide.<sup>9</sup> In the re-scaled index, countries with a rating of 6 display high levels of corruption, whereas index numbers closer to 0 are freer of corruption. The average level of corruption in the sample is 3, with the Democratic Republic of the Congo being the most corrupt and Finland the least.

As a robustness check, another measure of cross-national corruption perceptions from Transparency International is also used, *Corruption2*. The Corruption Perceptions Index is a composite index that ranks countries based on the perceived level of corruption in the public sector, which is based on surveys and assessments collected from various institutions. The index is widely used, both in the media and academic research (Lambsdorff 2006), although its time series comparability is limited. Table A2

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<sup>8</sup> Also see Schneider (2005).

<sup>9</sup> See Dreher and Schneider (2010), Fisman and Gatti (2002), and Treisman (2007) for some applications of this index.



shows that the correlation between the two measures of corruption, *Corruption1* and *Corruption2*, is also high (0.90) and statistically significant.

To account for the level of government decentralization within a country, three measures capture the various kinds of decentralization. The first measure, *DECENT-PHYSICAL*, measures the extent of physical decentralization by detailing the number of tiers, or subsets, of government, including the central government (e.g., states and counties in the United States; states, districts, and *tehsils* in India; and prefectures in Japan). Greater physical decentralization brings the government closer to the public, improving transparency and responsiveness to local needs while increasing the potential for illegal acts between the public and government officials.

Second, *DECENT-FISCAL* captures spending discretion at the local level (e.g., for health care, education, roads, and sanitation). This aspect of decentralization provides greater fiscal autonomy at the lower levels of government.

Finally, *DECENT-VITRUAL* is used to capture virtual decentralization. The measure employed is broader than the number of internet users that some studies have used (Elgin 2013). According to UNDESA (2004), the measure used in this study for virtual decentralization, e-government, is “[t]he use of information and communication technology and its application by the government for the provision of information and public services to the people.” E-government serves to increase accountability through transparency, enhance the efficient use of public resources, and improve the delivery of public services. Furthermore, e-government facilitates interactions between governments, between the government and businesses, and between the government and consumers.

Table A2 shows that the correlations between physical decentralization and the shadow economy (*Shadow1*) and corruption (*Corruption1*) are positive (0.09 and 0.23, respectively). The correlations between fiscal decentralization and the shadow economy and corruption are negative (−0.45 and −0.33, respectively), whereas the correlations between virtual decentralization and the shadow economy and corruption are negative (−0.80 and −0.83, respectively).

The other cross-country variables are from other international sources (Table A1). All models are estimated using cross-sectional data. The lack of good time series comparability of the available corruption indices is the main reason for this choice.

### 3.2 Empirical Estimation

To formalize the baseline models, extant literature on the shadow economy, corruption, and government decentralization is used.<sup>10</sup> Corruption and the shadow economy share some common determinants. As mentioned previously, the literature provides relatively greater guidance with regard to the effects of fiscal and physical decentralization. The estimated equations for the shadow economy and corruption, respectively, take the following general forms.<sup>11</sup>

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<sup>10</sup> For the shadow economy, see Gërkhani (2004) and Schneider and Enste (2000). For corruption, see Aidt (2003), Lambsdorff (2006), Shleifer and Vishny (1993), and Treisman (2000, 2007). For the effects of government decentralization, see Arikian (2004), and Panizza (1999).

<sup>11</sup> While corruption and the shadow economy are considered separately, there could be scenarios where the two activities are interdependent. See Buehn and Schneider (2012), Dell’Anno and Teobaldelli (2015), and Dreher and Schneider (2010).

### 3.2.1 Determinants of the Shadow Economy

Assuming that underground activities are driven by stringent regulations and high taxes and given the government structure, the cross-national determinants of the shadow economy are estimated using equation (1):

$$\text{Shadow economy}_{ij} = f(\text{Decentralization}_{jk}, \text{Economic conditions}_i, \text{Democracy}_i, \text{Transition}_i, \text{Asian}_i, \text{Regulation}_{im})$$

where

$i = 1, 2, 3, \dots;$

$j = \text{Shadow1}, \text{Shadow2};$

$k = \text{DECENT-VITRUAL}, \text{DECENT-PHYSICAL}, \text{DECENT-FISCAL};$  and

$m = \text{TAX}, \text{WageREG}, \text{PriceControls}, \text{LAW}.$

The focus in the empirical analysis is on the sign, magnitude, and statistical significance of the coefficients on the decentralization variable, with decentralization alternately measured by *DECENT-VITRUAL* (virtual), *DECENT-FISCAL* (fiscal), and *DECENT-PHYSICAL* (physical).

The dependent variable is alternately a specific and a broad measure of the shadow economy (*Shadow1* and *Shadow2*, respectively).

Turning to a discussion of the control variables for the shadow economy, to account for the level of development in the country, the log of real GDP per capita (*GDP*) is used, while a dummy variable is used to capture countries in transition (*Transition*) and those in Asia (*Asian*). Greater economic prosperity increases the opportunity costs of engaging in illegal activities (i.e., corruption and the shadow economy), and more prosperous countries may have better enforcement.

*Democracy* is an index used to control for the degree of democracy. More democratic nations have greater freedom of press and more transparent legal systems that curb illegal activities, including corruption and the shadow economy (Lambsdorff 2006). Alternately, the rule of law (*LAW*) can be used to gauge whether a consistent set of punishments form a deterrent to illegal acts.<sup>12</sup> Other important determinants of the shadow economy include higher tax rates (Corchón 1992) and burdensome regulations. To account for these, an index of top income tax rates and top marginal income and payroll tax rates (*TAX*), as well as one for burdensome regulations relating to minimum wages (*WageREG*), are included. Additionally, price controls (*PriceControls*) are included. Other things being the same, higher taxes and higher regulations prompt movements to the underground sector.

### 3.2.2 Determinants of Corruption

Based on the above discussion, the determinants of corruption are estimated via the following relation, with both the structure and size of the government now included in equation (2):

$$\text{Corruption}_{iz} = g(\text{Decentralization}_{jk}, \text{Economic conditions}_i, \text{Democracy}_i, \text{Transition}_i, \text{Asian}_i, \text{Government size}_i, \text{LAW}_i, \text{Protestant}_i)$$

$$z = \text{Corruption1}, \text{Corruption2}$$

<sup>12</sup> See Voigt (2012) for an interesting related discussion.

For denoting cross-national corruption as the dependent variable, *Corruption1* and *Corruption2* are employed. For determinants of corruption, *GDP* and *Democracy* serve as deterrents of corrupt behavior. *Democracy* allows voters a voice in the political sphere and to determine the competence of public officials. Transition countries, to the extent that they have underdeveloped institutions, are likely to experience greater corruption. To account for this, a dummy variable for transition countries (and for countries in Asia to see any regional differences in this regard) is included. The size of government (*GovtSize*) proxies for corruption opportunities (via bureaucratic red tape increasing rent-seeking opportunities). Alternately, a larger government may be associated with better monitoring (Guriev 2004, Rose-Ackerman 1999). Finally, the fraction of population that is Protestant (*Protestant*) has been shown to reduce corruption because of its strong moral compass (Lambsdorff 2006, Treisman 2000). This variable may be seen as accounting for social influences on corruption.

To estimate the relationship between decentralization and institutional quality given potential simultaneity issues, two-stage least squares (2SLS) regression is used (Figure 1). In response to growing concern over public corruption and the spread of the shadow economy, the government may increase its involvement in e-government to enhance transparency and instill confidence among the populace. The potential simultaneity prompts the use of instrumental variables to correct for this inherent endogeneity. To instrument *DECENT-VITRUAL*, numbers of internet users and telephone lines, and population density are used. The more users connected via telephone lines and the internet, the higher the perceived benefits of the government being online.

Further, *DECENT-FISCAL* is instrumented using *Age* (i.e., age of a country's democracy), *Federal* (i.e., federalist government structure), *Independent* (i.e., number of years since a nation's independence) and *Latitude*.<sup>13</sup> The relevancy and validity of these instruments are tested using three diagnostic tests reported at the bottom of each results table.<sup>14</sup>

## 4. RESULTS

Tables A3 and A4 report results of the effects of various forms of government decentralization on institutional quality. Given the potential simultaneity between these dependent variables and *DECENT-VITRUAL* in each case, 2SLS results are reported with *DECENT-VITRUAL* instrumented by *Internet*, *Telephone*, and *PopDen*. A similar accounting of simultaneity is also done in regard to *DECENT-FISCAL* in Table A3.<sup>15</sup> The  $R^2$ s are decent, and the other statistics confirm the validity of the instrument choice.

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<sup>13</sup> In contrast, Fisman and Gatti (2002) examined the effect of fiscal decentralization on corruption using a country's legal system to instrument fiscal decentralization.

<sup>14</sup> To determine the relevancy of the instruments, the Kleibergen and Paap (2006) rk LM statistic is used. Rejection of the null in this case indicates that the instruments are relevant. The first-stage F-statistics are also reported to check for correlations between the endogenous variable and instruments. However, if the instruments are only weakly correlated with the endogenous variables, this can lead to a bias. Consequently, the Kleibergen and Paap rk Wald statistic is used to test if the endogenous variable is only weakly correlated with the instruments. This statistic is compared to the critical values in Stock and Yogo (2005). Finally, the validity of the instruments is tested using the Hansen J statistic.

<sup>15</sup> As argued above, physical decentralization in the form of government tiers is generally fixed; thus, this variable is not endogenized. See Goel and Saunoris (2015) for an alternate treatment.

## 4.1 Effects of Decentralization on the Shadow Economy

Table A3 reports the main results, with *Shadow1* as the dependent variable. Both greater virtual and greater physical decentralization decrease the spread of the shadow economy. The signs on *DECENT-VITRUAL* and *DECENT-PHYSICAL* are negative and statistically significant in models 2.1–2.2. The results with regard to government tiers broadly support earlier findings by Buehn, Lessmann, and Markwardt (2013). In terms of relative magnitudes, a 10% increase in *DECENT-VITRUAL* would decrease the shadow economy by about 9%, while a similar increase in *DECENT-PHYSICAL* would have about one-third of that impact based on respective elasticities evaluated at corresponding means.

In other factors, greater democracy and minimum wage regulations increase the underground sector. Democracies may have slower court systems due to formal legal processes, which may encourage shadow operators. Minimum wage regulations may prompt some businesses to pay their employees in cash and “off the books.” Transition countries, *ceteris paribus*, have a larger shadow economy. This is consistent with underdeveloped institutions in transition nations. The effects of economic conditions (*GDP*), tax rates (*TAX*), and price controls (*PriceControls*) are statistically insignificant.

## 4.2 Effects of Decentralization on Corruption

Turning to the effects of decentralization on corruption, with corruption measured by *Corruption1*, the effect of *DECENT-VITRUAL* on corruption in Table A3 is negative and statistically significant. This effect of *DECENT-VITRUAL* is consistent with other findings in the literature with other corruption measures and/or sample of nations (i.e., Andersen 2009, Choi 2014, Kim 2014). Remarkably, the elasticity of corruption with respect to *DECENT-VITRUAL* is similar in magnitude to the elasticity of the shadow economy with respect to e-government (–0.9 in both cases).<sup>16</sup> The effect of government tiers or *DECENT-PHYSICAL* is also negative yet statistically insignificant. Thus, while government tiers proved effective in combating the shadow economy in Table A3, they fail to combat corruption.

Like models 2.1–2.2 with the shadow economy, transition countries also have greater corruption in model 2.3. A larger government size decreases corrupt activity. This finding is consistent with a larger government being able to devote more resources to monitoring. Further, nations with a larger proportion of Protestants have lower corruption, *ceteris paribus* (Lambsdorff 2006). The effects of GDP and democracy on corruption are insignificant. This finding is somewhat sensitive to the choice of the sample of nations considered and the time period covered (Lambsdorff 2006).

## 4.3 Additional Considerations

To verify the validity of the main results, a series of robustness checks are conducted. First, alternative measures of both the shadow economy and corruption are considered. This is useful, especially given the difficulties with effectively measuring these illegal activities. Second, an alternative measure of decentralization (*DECENT-FISCAL*) is considered, associated with the devolution of the spending authority to subnational governments. This form of decentralization has been widely studied, especially regarding its effects on corruption. Third, institutional quality is accounted for related to the rule of law (*LAW*). A consistent rule of law increases

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<sup>16</sup> Details available upon request.

the costs for illegal acts and thus is a deterrent. Finally, unique regional aspects of countries in Asia are considered.

#### 4.3.1 Robustness Check 1: Alternate Measures of the Shadow Economy and Corruption

Model 3.1 of Table A4 uses an alternate measure of the shadow economy based on the multiple indicators, multiple causes model (i.e., *Shadow2*) as the dependent variable. As discussed above, the *Shadow2* measure is somewhat broader than the *Shadow1* measure. The overall format of the estimated equation is the same as equation (1).

With *Shadow2* as the dependent variable, *DECENT-VIRTUAL* again has a negative and statistically significant coefficient. However, the effect of *DECENT-PHYSICAL* is now statistically insignificant. Thus, while the effects of virtual decentralization on the shadow economy are robust to alternate measures of the shadow economy, those of physical decentralization are not. In other results, the effects of economic conditions and regulations are insignificant in this case. However, similar to Table A2, transition nations have a larger shadow sector, *ceteris paribus*.

Model 3.2 of Table A4 uses the corruption perceptions index developed by Transparency International as the dependent variable. *Corruption2* is based on perceptions about corruption, while *Corruption1* is based on expert ratings of (mainly political) corruption. Again, *DECENT-VIRTUAL* has negative and significant effects on *Corruption2*, while *DECENT-PHYSICAL* does not. Transition nations are more corrupt, while predominantly Protestant nations are less so.

The effect of *GDP* is positive and marginally significant. This is consistent with bribe affordability arguments, rather than with greater economic prosperity increasing the opportunity costs of corruption. The effects of government size, democracy, and fractionalization are statistically insignificant.

#### 4.3.2 Robustness Check 2: Effects of Fiscal Decentralization

The multidimensionality of decentralization prompts the use of alternate measures of decentralization. Others have also considered fiscal decentralization in its effects on the size of the shadow economy (e.g., Buehn, Lessmann, Markwardt 2013) and corruption (e.g., Arian 2004). To this end, a measure of fiscal decentralization in models 2.2 and 2.3 from Table A3 are included, and these results are in models 3.3 and 3.4 in Table A4. Because of the possible reverse feedback from both shadow and corrupt dealings, fiscal decentralization is instrumented by using *Age*, *Federal*, *Independent*, and *Latitude* as external instruments (Treisman 2006). These instruments can be considered exogenous and broadly influence the structure of government over the long term.

The coefficient on *DECENT-VIRTUAL* is negative, although insignificant, in effecting the size of the shadow economy, and negative and significant for reducing corruption. The differences are partly related to the significant drop in observations and degrees of freedom between the two sets of results. Similar to the main findings the coefficient on *DECENT-PHYSICAL* is negative and significant in model 3.3 and insignificant in model 3.4.

To the effects of fiscal decentralization, the coefficient on *DECENT-FISCAL*, although negative, is insignificant in model 3.3, and positive and insignificant in model 3.4. Therefore, fiscal decentralization does not prove to statistically impact the size of the shadow economy nor the level of corruption. These findings are consistent with Buehn,

Lessmann, and Markwardt (2013), where they found that government tiers have a negative effect on the size of the shadow economy, and failed to find a statistical influence of fiscal decentralization on the shadow economy. On the other hand, the results regarding the ineffectiveness of fiscal decentralization in controlling corruption differ from those obtained by Fisman and Gatti (2002), who considered only fiscal government decentralization.

In models 3.3 and 3.4, alternate measures of institutions are considered by replacing *Democracy* with a measure capturing the level of rule of law (*LAW*) within a country. The coefficient on this variable is negative and significant in both cases, thus greater rule of law helps contain the spread of the shadow economy and reduces corruption. In other effects, the coefficients on the control variables are somewhat consistent with those in Table A2, with some notable differences. In particular, the coefficient on *WageREG* is now insignificant in model 3.3, and the coefficients on *Transition* and *GovtSize* are both insignificant.

### 4.3.3 Robustness Check 3: Consideration of Countries in Asia

Models 3.5 and 3.6 in Table A4 replace *Transition* with a dummy variable equal to one if the country is in Asia (*Asian*). This provides a dimension of regional effects. Further, Asia includes many of the most populated, and several of the most densely populated, nations in the world. Plus, many countries in Asia were colonized in previous centuries. All of these factors either shaped institutions over time or altered propensities to engage in illegal acts (e.g., changing discount rates with greater population and/or greater population density).

Overall, the results remain consistent with those reported in Table A2. *DECENT-VIRTUAL* negatively impacts both the size of the shadow economy and corruption, whereas *DECENT-PHYSICAL* negatively impacts the size of the shadow economy and fails to influence the level of corruption. The coefficient on *Asian* is insignificant in model 3.5, with the shadow economy as the dependent variable, but positive and significant in model 3.6, with corruption as the dependent variable. Thus, on average, countries in Asia tend to have more public corruption, but not necessarily a larger underground sector.

## 5. CONCLUSION

Overall, virtual decentralization is relatively more effective in controlling both corruption and the shadow economy, relative to other forms of decentralization. In the literature, the effectiveness of (physical) decentralization, in some cases, can be seen as supporting related findings (e.g., Dell'Anno and Teobaldelli 2015; Buehn, Lessmann, Markwardt 2013); however, the results with regard to virtual decentralization are new. Further, the effectiveness of e-government in reducing corruption supports earlier findings with a different specification and sample and without consideration of the shadow sectors (e.g., Andersen 2009; Choi 2014).

In other findings, rule of law is effective in checking both corruption and the shadow economy, nations with predominantly Protestant populations are less corrupt, and transition nations show greater corruption and more shadow economies. Countries in Asia are more corrupt but do not necessarily have larger shadow sectors.

Thus, it can be concluded that policy makers looking to improve governance and to control corruption and the shadow economy should consider the potential benefits of virtual decentralization. The internet-based provision of government services may be cheaper, amenable to faster alterations (e.g., increasing the scope of services offered), have a greater geographic reach, and be relatively less bound by legislative red tape. As the digital divide narrows over time, these benefits are likely to expand.

These are superior advantages over physical decentralization, although not all government services are as equally amenable to virtual decentralization. A larger government, via physical decentralization, could curb corruption through strengthened checks and balances. Moreover, the effectiveness of the rule of law in controlling both corruption and the underground sector is a signal for nations to strengthen this aspect. The externalities to the underground sector from strengthened wage regulations should also be recognized by policy makers. Finally, transition nations warrant some special attention to control corruption and the shadow economy.

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**Table A1: Variable Definitions, Summary Statistics and Sources**

<b>Variable</b>	<b>Description [countries; mean; standard deviation]</b>	<b>Source</b>
<i>Shadow1</i>	The size of the shadow economy calculated using the currency demand approach and dynamic panel data methods (% of GDP). Data available up to 2006 [111; 31.02; 9.44]	Alm and Embaye (2013)
<i>Shadow2</i>	The size of the shadow economy calculated using the multiple indicators, multiple causes model (% of GDP). Data averaged from 1999 to 2007. [162; 33.04; 12.75]	Schneider, Buehn, and Montenegro (2010)
<i>Corruption1</i>	Assessment of corruption in the political system. Originally the index scale ranged from 0 to 6, with lower levels indicating higher corruption, rescaled so that higher values indicate higher values of corruption. Data available up to 2012. [143; 3.07; 1.10]	PRS Group. International Country Risk Guide. <a href="http://www.prsgroup.com">http://www.prsgroup.com</a>
<i>Corruption2</i>	Corruption perceptions index. This index measures the perceived corruption in the public sector. The index is on a scale from 0 to 10, with 0 being the most corrupt, and 10 being the least corrupt. The index was rescaled so that higher scores indicate more corruption. Data averaged from 1998 to 2013. [184; 5.94; 2.06]	Transparency International. <a href="http://www.transparency.org/">http://www.transparency.org/</a>
<i>DECENT-VITRUAL</i>	E-government development index. This is a composite measure of the provision of and investment in online services, telecommunications connectively, and human capacity. The index is based on a scale 0 to 1, with 1 indicating the highest degree of e-government. Data averaged from 2003 to 2014. [190; 0.42; 0.20]	UNDESA (2014)
<i>DECENT-PHYSICAL</i>	Number of tiers of government, including central. "Each government in a country has a jurisdiction, an area of space or a subset of the country's population over which that government has constitutional authority. A tier of government is the subset of governments in a country such that all members of this subset have jurisdictions that are contained by the same number of (other governments') jurisdictions. For instance, all governments whose jurisdictions are contained only by the jurisdiction of the national government are denoted "first-tier" subnational governments. All those whose jurisdictions are contained by that of the national government and that of one "first-tier" government are "second-tier" governments." Data as of mid-1990s. [155; 3.72; 0.91]	Treisman (2008)
<i>DECENT-FISCAL</i>	Subnational government expenditures (% of total government expenditures). Data averaged up to 2000. [70; 22.54; 14.37]	IMF (2001). Derived from IMF Government Finance Statistics
<i>GDP</i>	The natural log of GDP per capita in constant 2000 US dollars. Data up to 2012. [199; 8.13; 1.65]	World Bank (2014)
<i>PriceControls</i>	A subcomponent of business regulations measuring the extent of price controls on a scale from 0 to 10. The index was rescaled so that higher scores indicate more regulation. Data averaged from 2000 to 2007. [127; 5.05; 1.95]	Gwartney and Lawson (2009)
<i>Democracy</i>	A measure of democracy (index) ranging from 0 to 10 with higher numbers signifying higher degrees of democracy. This measures the general qualities of political institutions and processes. Data up to 2013 [165; 5.22; 3.67]	Marshall and Jaggers (2011)
<i>WageREG</i>	A subcomponent of labor market regulations on a scale from 0 to 10. The index was rescaled so that higher scores indicate more regulation. Data averaged from 2000 to 2007. [136; 4.81; 2.23]	Gwartney and Lawson (2009)
<i>TAX</i>	Index based on the top marginal income tax rate where countries with higher marginal tax rates that take effect at lower income thresholds receive lower ratings. The index is from 0 to 10 and was rescaled so that higher scores indicate least favorable outcomes. Data averaged from 2000 to 2007. [122; 3.18; 2.34]	Gwartney and Lawson (2009)

*continued on next page*

**Table A1** *continued*

<b>Variable</b>	<b>Description [countries; mean; standard deviation]</b>	<b>Source</b>
<i>Protestant</i>	The percent of the population that belonged to the Protestant religion in 1980. [205; 14.76; 23.38]	La Porta, et al. (1999)
<i>GovtSize</i>	Index based on government expenditures, taxes, and enterprises. The index is from 0 to 10 and was rescaled so that higher scores indicate least favorable outcomes. Data averaged from 2000 to 2007. [140; 3.72; 1.39]	Gwartney and Lawson (2009)
<i>Internet</i>	Internet users per 100 people. Data available up to 2013. [202; 17.04; 15.35]	World Bank (2014)
<i>Telephone</i>	Telephone lines per 100 people. Data available up to 2013. [202; 19.40; 19.96]	World Bank (2014)
<i>PopDen</i>	Population density per square kilometer of land area. Data available up to 2012. [210; 349.70; 1661.06]	World Bank (2014)
<i>LAW</i>	Index of rule of law. This index reflects perceptions of society abiding by rules as well as the quality of contract enforcement, property rights, the police, and the courts. Index ranges from -2.5 to +2.5, with higher values corresponding to better outcomes. Data used from 1996 to 2012. [213; 0.006; 0.99]	Kaufmann, Kraay, Mastruzzi (2010)
<i>Independent</i>	Years since country's independence, ranging from 0 to 250 (the latter value is used for all non-colonized countries). [85; 119.73; 89.76]	Persson and Tabellini (2003)
<i>Age</i>	Age of country's democracy. Defined as $Age = (2000 - Z)/200$ , where $Z$ is the first year of democratic rule. [85; 0.21; 0.22]	Persson and Tabellini (2003), Table 4.1
<i>Latitude</i>	Rescaled variable for country's latitude: the absolute value of latitude divided by 90 and taking values between 0 and 1. [78; 0.32; 0.19]	Persson and Tabellini (2003)
<i>Federal</i>	Dummy variable that equals one for a country that has a federalist government structure, zero otherwise. [83; 0.16; 0.37]	Persson and Tabellini (2003)
<i>Transition</i>	Dummy variable equal to one if the country is a transition country and zero otherwise. Countries classified as transition include Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Romania, Russian Federation, Serbia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.	United Nations. <a href="http://www.un.org">http://www.un.org</a>
<i>Asian</i>	Dummy variable the equals one if the country is an Asian country and zero otherwise. (N = 49)	Countries-of-the-World.com. <a href="https://www.countries-of-the-world.com/countries-of-asia.html">https://www.countries-of-the-world.com/countries-of-asia.html</a>

GDP = gross domestic product.

Notes: All data are annual by country, averaged over the usable data starting in 1990, unless otherwise noted.

**Table A2: Correlation Matrix of Key Variables**

	<i>Shadow1</i>	<i>Shadow2</i>	<i>Corruption1</i>	<i>Corruption2</i>	<i>DECENT-VITRUAL</i>	<i>DECENT-PHYSICAL</i>	<i>DECENT-FISCAL</i>
<i>Shadow1</i>	1.000						
<i>Shadow2</i>	0.788*** [0.000]	1.000					
<i>Corruption1</i>	0.761*** [0.000]	0.706*** [0.000]	1.000				
<i>Corruption2</i>	0.810*** [0.000]	0.697*** [0.000]	0.945*** [0.000]	1.000			
<i>DECENT-VITRUAL</i>	-0.800*** [0.000]	-0.683*** [0.000]	-0.827*** [0.000]	-0.883*** [0.000]	1.000		
<i>DECENT-PHYSICAL</i>	0.088 [0.520]	0.119 [0.382]	0.233* [0.084]	0.315** [0.018]	-0.305** [0.022]	1.000	
<i>DECENT-FISCAL</i>	-0.446*** [0.001]	-0.311** [0.019]	-0.331** [0.013]	-0.312** [0.019]	0.442*** [0.001]	0.112 [0.409]	1.000

\*\*\* denotes statistical significance at 1% level, and \*\* denotes statistical significance at the 5% level.

Notes:

1. N = 56.
2. List-wise deletions are used to handle missing data.

**Table A3: Government Decentralization and Institutional Quality**

Dependent Variable	<i>Shadow1</i>		<i>Corruption1</i>
	(2.1)	(2.2)	(2.3)
<i>DECENT-VITRUAL</i>	-53.755*** (9.799)	-51.310*** (11.156)	-5.322*** (1.231)
<i>DECENT-PHYSICAL</i>	-2.228*** (0.685)	-2.232*** (0.678)	-0.027 (0.070)
<i>GDP</i>	0.398 (1.410)	0.220 (1.655)	0.183 (0.137)
<i>Democracy</i>	0.543** (0.226)	0.606** (0.250)	-0.028 (0.022)
<i>TAX</i>	-0.119 (0.282)	-0.169 (0.291)	
<i>WageREG</i>	0.991*** (0.318)	0.964** (0.397)	
<i>PriceControls</i>		0.312 (0.364)	
<i>GovtSize</i>			-0.094** (0.039)
<i>Protestant</i>			-0.011*** (0.003)
<i>Transition</i>	4.046*** (1.543)	3.527** (1.630)	0.876*** (0.173)
Observations	92	90	112
R-squared	0.722	0.729	0.707
<b>Diagnostic Tests</b>			
First Stage F-Statistic	31.87*** [0.000]	23.91*** [0.000]	35.61*** [0.000]
Kleibergen-Paap rk Wald F statistic	31.87	23.91	35.61
Kleibergen-Paap rk LM statistic	19.92*** [0.000]	18.44*** [0.000]	17.94*** [0.000]
Hansen's J statistic	3.305 [0.192]	4.069 [0.131]	3.401 [0.183]

Notes:

1. See Table A1 for variable details.
2. Constant included but not reported.
3. All models are estimated using two-stage least squares, with *DECENT-VITRUAL* treated as endogenous.
4. Excluded instruments include *Internet*, *Telephone*, and *PopDen* (see Goel and Saunoris 2015).
5. Robust standard errors are in parentheses, and probability values are in brackets.
6. Asterisks denote significance at the following levels: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.10$ .
7. The critical values for the Kleibergen-Paap rk Wald F statistic are in Stock and Yogo (2005).

**Table A4: Government Decentralization and Institutional Quality:  
Additional Considerations**

Dependent Variable	Alternate Measures		Fiscal Decentralization		Countries in Asia	
	Shadow2 (3.1)	Corruption2 (3.2)	Shadow1 (3.3)	Corruption1 (3.4)	Shadow1 (3.5)	Corruption1 (3.6)
<i>DECENT-VITRUAL</i>	-55.792*** (16.710)	-12.937*** (2.642)	-20.101 (17.226)	-3.629*** (1.399)	-48.585*** (9.501)	-4.722*** (1.375)
<i>DECENT-PHYSICAL</i>	0.603 (1.043)	0.173 (0.111)	-3.217*** (1.100)	0.034 (0.125)	-2.625*** (0.625)	-0.106 (0.073)
<i>DECENT-FISCAL</i>			-0.100 (0.073)	0.006 (0.006)		
<i>GDP</i>	-0.332 (2.005)	0.448* (0.267)	-1.523 (1.437)	0.194 (0.167)	-0.373 (1.287)	0.062 (0.153)
<i>Democracy</i>	0.611 (0.435)	0.067 (0.042)			0.542** (0.258)	-0.015 (0.028)
<i>TAX</i>	-0.589 (0.459)		0.438 (0.292)		-0.132 (0.288)	
<i>WageREG</i>	0.491 (0.595)		0.192 (0.840)		0.872*** (0.309)	
<i>GovtSize</i>		-0.093 (0.082)		-0.027 (0.053)		-0.059 (0.036)
<i>Protestant</i>		-0.018*** (0.004)		-0.010*** (0.003)		-0.011*** (0.003)
<i>LAW</i>			-4.197* (2.398)	-0.688*** (0.130)		
<i>PriceControls</i>			-0.193 (0.523)			
<i>Transition</i>	9.828*** (2.685)	1.770*** (0.316)	5.719*** (0.777)	0.074 (0.145)		
<i>Asian</i>					-0.469 (1.687)	0.299* (0.172)
Observations	107	124	40	45	92	112
R-squared	0.550	0.721	0.870	0.871	0.716	0.675
<b>Diagnostic Tests</b>						
First Stage F-Statistic						
<i>DECENT-VITRUAL</i>	33.85*** [0.000]	39.05*** [0.000]	8.92*** [0.000]	5.35*** [0.000]	32.15*** [0.000]	34.78*** [0.000]
<i>DECENT-FISCAL</i>			11.87*** [0.000]	10.80*** [0.000]		
Kleibergen-Paap rk Wald F statistic	33.85	39.05	5.430	7.200	32.15	34.78
Kleibergen-Paap rk LM statistic	22.11*** [0.000]	21.73*** [0.000]	6.838 [0.336]	5.957 [0.428]	23.84*** [0.000]	21.59*** [0.000]
Hansen's J statistic	0.707 [0.702]	2.764 [0.251]	8.721 [0.121]	0.785 [0.978]	2.462 [0.292]	2.297 [0.317]

Notes:

1. See Table A1 for variable details.
2. Constant included but not reported.
3. All models are estimated using two-stage least squares, with *DECENT-VITRUAL* and *DECENT-FISCAL* treated as endogenous.
4. Excluded instruments for *DECENT-VITRUAL* include *Internet*, *Telephone*, and *PopDen*.
5. Excluded instruments for *DECENT-FISCAL* include *Age*, *Federal*, *Independent*, and *Latitude*.
6. Robust standard errors are in parentheses and probability values are in brackets.
7. Asterisks denote significance at the following levels: \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.10.
8. The critical values for the Kleibergen-Paap rk Wald F statistic are in Stock and Yogo (2005).