The Devil is in the Shadow: Do Institutions Affect Income and Productivity or only Official Income and Official Productivity?

Axel Dreher, Pierre-Guiiaume Méon
and Frederich Schneider

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Axel Dreher[1], Pierre-Guillaume Méon[2], Friedrich Schneider[3]

Abstract:

This paper assesses the relationship between institutions, output, and productivity, when official output is corrected for the size of the shadow economy. Our results confirm the usual positive impact of institutional quality on official output and total factor productivity, and its negative impact on the size of the underground economy. However, once output is corrected for the shadow economy, the relationship between institutions and output becomes weaker. The impact of institutions on total ("corrected") factor productivity even becomes insignificant. Differences in corrected output must then be attributed to differences in factor endowments. These results survive several tests for robustness.

Keywords: shadow economy, income, aggregate productivity, development accounting

JEL Classification: O11, O17, O47, O5

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[1] *ETH Zurich, KOF Swiss Economic Institute, Weinbergstrasse 35, CH-8092 Zürich, Switzerland and CESifo, Germany,* (*mail@axel-dreher.de*)

[2] *University of Brussels, DULBEA, CP-140, avenue F.D. Roosevelt 50, 1050 Bruxelles, Belgium.* (*pgmeon@ulb.ac.be*)

[3] *Department of Economics, Johannes Kepler University of Linz, A-4040 Linz-Auhof, Austria.* (*friedrich.schneider@jku.at*)

1. Introduction

The consensus that institutions are a key determinant of economic development has led international organizations to devote attention and resources to improving the institutional frameworks of developing countries. Various conventions have accordingly been set up, such as the 1998 UN resolution or the 1999 OECD's "Convention on combating bribery." The political consensus is indeed backed by a parallel consensus based on results from a decade of empirical research. Spurred by the seminal papers of Mauro (1995) or Knack and Keefer (1995), this line of research has repeatedly concluded that ailing institutions are associated with lower GDP per capita growth. Later studies, such as Hall and Jones (1999) and Acemoglu et al. (2000), extended that finding to the level of per capita incomes. Hall and Jones (1999) furthermore observed that the bulk of the relationship between institutions and income runs through the impact of institutions on total factor productivity.

Although those consonant observations have drawn a consistent picture of the relationship between institutions and development, they all share a common drawback that may turn out to be crucial in the context of developing economies in particular: they use official output figures. However, official output figures neglect a sizeable part of economic activity, which takes place in the informal sector and therefore remains unrecorded in official statistics, namely the shadow economy. According to Schneider (2005a, 2005b), who defines the shadow economy as currently unregistered economic activities that contribute to the officially calculated (or observed) Gross National Product, the shadow economy amounted on average to 39 percent in developing countries, and up to 40 percent in transition countries in 2002/2003. Those figures consequently call for caution in interpreting empirical results emphasizing the negative impact of defective institutions on incomes. They in fact emphasize that official incomes decrease when, for instance, corruption increases or the rule of law deteriorates. They do not guarantee, however, that the same holds for total income, defined as the sum of official and unofficial incomes.

Previous research moreover suggests that the shadow economy frolics in countries mired with defective institutions, thus acting as a substitute for the official economy. Johnson et al. (1997), for instance, model corruption to reduce the shadow economy because corruption works as a form of taxation and regulation, which drives entrepreneurs underground. Hindriks et al. (1999) also argue that the shadow economy is a complement to corruption. This is because, in their view, tax payers can collude with corrupt inspectors so that the latter underreport the tax liability of the tax payer in exchange for a bribe. According to the empirical results in Dreher and Schneider (2006), better institutions reduce the size of the shadow economy. Similarly, Johnson et al. (1998a) observed a one-point increase in Transparency International's corruption index to imply a 5.1 points fall in the share of the shadow economy.

To summarize, good institutions seem to increase official output, while at the same time reducing unofficial output. One may accordingly contend that the observed correlation between bad institutions and lower income may be less substantial than it first seems. It may only result from a drop in recorded output. In other words, production might not disappear, it might only go underground, which is a special case of Hirschman (1970)'s exit option, as Schneider and Enste (2000) argue. Even if the substitution from official to shadow production would be imperfect, the negative impact of bad institutions on overall income would be dampened. This intuition is consistent with Johnson et al. (1998b), reporting the relationship between corruption and growth to become insignificant once the shadow economy is added as an explanatory variable. At any rate, a systematic investigation of the relationship between institutions and total income, as opposed to official income, is warranted. This is precisely the aim of this paper.

To anticipate our main results, we confirm the positive impact of institutional quality on official output and total factor productivity, and its negative impact on the size of the underground economy reported in the previous literature. However, once output is corrected for the shadow economy, the relationship between institutions and output becomes weaker. The impact of institutions on total ("corrected") factor productivity even becomes insignificant.

Our line of reasoning is along the following steps. In a first section, we correct official output figures for the shadow economy. We then compare the distribution of per capita incomes using both raw and corrected figures. In a second section we probe deeper in the impact of the shadow economy on output by performing a development accounting analysis, following Hall and Jones (1999) and Caselli (2005). Namely, differences in incomes are broken down into differences in factor endowments and differences in total factor productivity. The next section uses that decomposition to determine the channels through which institutions affect income per capita. We thus check whether institutions are still significantly correlated with output per capita and total factor productivity once corrected for the size of the shadow economy. The last section concludes.

2. Correcting output figures

The prerequisite to correcting output figures is to measure the shadow economy. Data for the shadow economy are taken from Schneider (2005a, 2005b).[1] Schneider calculates the size and development of the shadow economy of 145 countries, including developing, transition, and highly developed OECD countries, over the period 1999 to 2003. In a first step Schneider (2005b) estimates the size of the shadow economy of 96 developing countries with the help of structural equation modeling (dynamic multiple causes, multiple indicators, DYMIMIC), employing variables such as direct and indirect taxation, custom duties, government regulations, the rate of unemployment, growth rate of real GDP, and currency circulation. The sample covers Central and South America, Africa, Asia and South-West-Pacific Islands. Moreover, the data cover 25 Central and Eastern European Former Soviet Union countries, 3 Communist countries, and 21 high developed OECD countries. While the DYMIMIC approach produces estimated relative sizes of the shadow economy, another step is necessary to get to absolute values. In order to calibrate absolute figures of the size of the shadow economies from the relative DYMIMIC estimation results, Schneider uses previous estimates for a number of countries (e.g. Australia, Austria, Germany, Hungary, Italy, India, Peru, Russia and the United States).[2]

According to these data, the average size of the shadow economy in percent of official GDP in 37 African states is 41 percent. In Central and South America the size of the shadow economy amounts to 41 percent. In Asia the average value is much lower (29 percent). Regarding the transition countries in the sample, the respective value is 38 percent, and for the OECD 17 percent. Looking at the unweighted average of the 145 countries in the sample, the average size of the shadow economy is 34 percent in 1999/2000.

We added the shadow economy output to the official output figures, thereby obtaining what we refer to as total output. The data on official output stem from the Penn World Tables version 6.2. Table 1 below compares official (y) and total (y_{tot}) output per worker measured in PPP dollars. We focus on the year 2000, because it maximizes the number of observations in our sample. We report data on two samples: First, we describe the largest sample for which we could find data on output per worker and the shadow economy, which features 136

[1] We test for the robustness of our results by employing alternative estimates of the shadow economy below.

[2] These external estimates are derived employing the currency demand method. For the sources of these external estimates see Schneider (2005b, page 21). The most widely used methods to calculate the size of the shadow economy are described in Appendix E. For more details see Schneider (2007).

countries. Second, we use a restricted sample for which we could not only find data on output per worker and the shadow economy but also on human and physical capital stocks.

Table 1: Distribution of official and total output

	Largest sample		Restricted sample	
	y	y_{tot}	y	y_{tot}
Mean	18940.73	23640.14	22834.13	27998.54
Standard deviation	18995.49	21998.34	20338.46	23058.87
Maximum/Minimum	75.83	59.46	38.50	31.14
Number of countries	136	136	76	76

y denotes official output per worker and y_{tot} total output per worker defined as official output plus the shadow economy.

As Table 1 shows, adding the output produced in the shadow economy to official output increases both the mean and the standard deviation of output. This is not surprising. Since the shadow economy can by definition not be negative, our correction can only increase output. However, Table 1 also reports the ratio of maximum to minimum output. This ratio decreases with the inclusion of the shadow economy to the output figures in both samples, which suggests that the distribution of outputs is more concentrated.

This is due to the fact that the shadow economy tends to be larger in poorer countries. To be more specific, the coefficient of correlation between the share of the shadow economy and official output per worker is –0.67 in the larger sample and –0.71 in the restricted sample. Official figures therefore tend to overestimate the differences in output across countries. It is thus unsurprising that the observed differences in outputs are reduced when the shadow economy is taken into account. In the next section we investigate the impact of this correction on the results of development accounting.

3. Development accounting with the shadow economy

As official figures are biased downward in poorer countries, they may lead to underestimating these countries' productivities. In this section, we therefore estimate productivities across countries with and without the shadow economy, and compare the results. To do so we first need to present the development accounting method and the data on which it was applied.

3.1. The development accounting method

The basic aim of development accounting is estimating countries' outputs as a function of their factor endowments and comparing the estimated figures with actual output figures. The difference between the two gives total factor productivity (TFP), or the Solow residual, depending on the reader's optimism.

To do so, the standard method in the literature is the calibration approach surveyed by Caselli (2005), and used by King and Levine (1994), Klenow and Rodriguez-Clare (1999), Prescott (1998) and Hall and Jones (1999), among others. According to that method, an aggregate production function of the following form is assumed:

$$Y = AK^{\alpha}(Lh)^{1-\alpha} \quad (1)$$

where Y is the country's output, and K its aggregate capital stock. L measures the country's number of workers, and h is the average human capital stock. Lh is therefore a measure of the labor force adjusted for its quality; α is a parameter that measures the contribution of capital to output. A is total factor productivity.

We rewrite the production function in per-worker terms, giving:

$$y = Ak^{\alpha}h^{1-\alpha} \quad (2)$$

where lower-case letters refer to per-worker variables.

To compute A, one therefore needs a value for α and data on Y, K, L, and h. It is commonly assumed that a reasonable estimate for α is around 0.3, such as in Caselli (2005), Hall and Jones (2003), Klenow and Rodriguez-Clare (1999), Prescott (1998), or Collins et al. (1996).[3] However, although this parameter's value is critical in development accounting exercises, as Caselli (2005) shows, the specific value is admittedly arbitrary. True, it corresponds to the US long run average, but may be quite different for other countries. Indeed, the estimates of α that are reported in the literature do vary widely. Thus, Cavalcanti Ferreira et al. (2004) report estimates of α that are approximately equal to 0.43. Moreover, estimates of α obtained when the production function is estimated thanks to efficiency frontiers techniques frequently reach 0.8, as in Kneller and Stevens (2003). Abu-Qarn and Abu-Bader (2007) assess α in MENA countries and conclude that the share of capital often exceeds 0.6 in those countries. They even report estimates exceeding 0.9 for the region's α. When studying OECD countries, Abu-Qarn and Abu-Bader (2007) also reject the 0.3 estimate and find that alpha robustly exceeds 0.5. However, the most systematic attempt at assessing

[3] To be specific, Caselli (2005) and Hall and Jones (2003) precisely assume $\alpha = 0.3$, whereas Prescott (1998) considers $\alpha = 0.25$, and Collins et al. (1996) assume $\alpha = 0.35$.

the share of capital in a large sample of countries is Senhadji's (2000), providing estimates for a sample of 88 developed and developing countries. He also rejects the estimate of 0.3. He moreover observes large cross-country variations in that parameter. However, the world mean and the world median are found to be 0.55 and 0.57, respectively.

As 0.3 therefore seems a very small value for α, and any exogenously imposed value is completely arbitrary, we endogenized the magnitude of that parameter, following various methods. Specifically, we first estimated the coefficient of the Cobb-Douglas production function given by (2) on our cross-country sample. This allowed us to use both official and total output. We then used the panel dimension of our data over the period 1980-2000.[4] We first computed pooled and between regressions. We then ran a panel regression with fixed country effects and subsequently added fixed time effects. We also ran two random effect regressions, one including country effects only, and another including random time effects also.

The results are displayed in the appendix. Although the estimates of α vary from one regression to another, they remain in a fairly narrow range of 0.5-0.6. They approximately average to 0.57, which corresponds to Senhadji's (2000) estimate of the world median. We will therefore use that value in our calculations below. Note, however, that using the mean value of 0.55 obtained by Senhadji does not change our results. Arguably, an α of 0.57 remains a conservative guess, as Senhadji (2000) reports estimates of alpha for individual countries or regions that often exceed it. This value of α allows investigating the impact of increasing the capital share in the production function, while leaving a role for differences in TFP in explaining cross-country differences in per worker output. As Caselli (2005) showed, variations in factor endowments explain the totality of cross-country differences in output per worker with values of α exceeding 0.6. However, we will test the robustness of our results by setting α to 0.6 in the last section of this paper. We also employ the value of 0.3 as proposed in much of the earlier literature.

The number of workers was computed from the Penn World Tables 6.2 dataset.[5] The human capital stock is usually computed as a function of years of schooling in the population. Following Hall and Jones (1999) and Caselli (2005), we accordingly define h as:

$$h = e^{\phi(s)} \quad (3)$$

[4] We restricted our observations to that period to minimize the impact of the initial capital stock.

[5] Specifically, the number of workers was obtained by dividing total GDP by GDP per worker, that is rgdpch*pop*1000/rgdpwok according to notations in the PWT6.2.

where s is the average number of years of schooling in the population over 25 years old in Barro and Lee's (2001) dataset, and ϕ a piecewise linear function such that $\phi(s) = 0.134*s$ if $s \leq 4$, $\phi(s) = 0.134*4 + 0.101*(s - 4)$ if $4 < s \leq 8$, and $\phi(s) = 0.134*4 + 0.101*4 + 0.068*(s - 8)$ if $s > 8$. Since Hall and Jones (1999), this definition of human capital is routinely used in development accounting. Its motivation is the following. According to our model, a worker's wage should be proportional to the worker's human capital. The relationship between wage and education is commonly assumed log-linear at the country-level, but the cross-country pattern of the education-wage profile seems convex. Hall and Jones (1999) therefore resorted to a piecewise linear specification to take stock of within and cross-country evidence. In Barro and Lee's dataset, the last year for which this statistic is available is 2000.

The last set of data required for our calculations is the stock of capital. We again followed the literature and computed it by applying the perpetual inventory method, where the capital stock of a particular year is defined as the sum of past investments to which a depreciation rate is applied. Hence, we assume that the capital stock is:

$$K_t = K_{t-1}*(1 - \delta) + I_{t-1} \tag{4}$$

Again, data on real investment in PPP terms were obtained from the Penn World Tables 6.2.[6] That data is available from 1950 until 2004. However, not all countries have complete series for the entire period. We therefore restricted our analysis to countries for which the information was available at least from 1970.

To apply the above formula we, however, need the initial capital stock. Still following Caselli (2005) and Hall and Jones (1999), we assume that the capital stock in the initial year is equal to its steady-state value in the Solow growth model, namely $K_0 = I_0 / (g + \delta)$, where δ is the depreciation rate, which is usually set to 0.06 in the literature, I_0 is the value of investment in the first year for which an observation is available, and g the average rate of growth for the investment series between that year and 1970.[7]

Finally we used two definitions of output per worker. One was directly taken from the Penn World Tables 6.2 dataset.[8] The other was corrected for the shadow economy, like in the previous section. Overall we could obtain data on output per worker, physical capital, human

[6] That is rgdpl*pop*ki in PWT6.2.

[7] Note that the impact of K_0 on the capital stocks in 2000 is quite small, as we use no base year subsequent to 1970. Since the annual rate of depreciation is six percent, the maximum share of the initial capital stock still in use in 2000 cannot exceed 15% of its initial value.

[8] It is referred to as rgdpwok in PWT6.2.

capital, and the shadow economy for 76 countries in the year 2000. The key point now is to determine the extent to which the inclusion of the shadow economy in output figures affects the observed role of the residual in explaining cross-country income differences. Put differently, we aim at measuring the impact of that correction on the capacity of factor endowments to predict income differences.[9]

To do so, we compare actual output per worker figures with output predicted by a model only considering factor endowments, that is $y_{KH} \equiv k^{\alpha} h^{1-\alpha}$, called the factor-only model. We then assess its relevance by computing the two measures of success defined in Caselli (2005). The first one is the ratio of the log-variance of the factor-only output to the log-variance of observed output. As it is sensitive to outliers, it is complemented by the ratio of the 90th to the 10th percentile of the factor-only output to the ratio of the 90th to the 10th percentile of observed output. More precisely, those measures are defined as:

$$success_1 \equiv \frac{var[log(y_{KH})]}{var[log(y)]} \tag{5a}$$

$$success_2 \equiv \frac{y_{KH}^{90} / y_{KH}^{10}}{y^{90} / y^{10}} \tag{5b}$$

3.2. Results

The two measures of success were computed once with official output figures and once with output figures corrected for the shadow economy. Table 2 below displays the results of our calculations:

Table 2: Measures of success of the factor-only model

	$success_1$	$success_2$
Official output	0.571	0.705
Total output	0.797	0.901

The results displayed in table 2 are in line with the usual findings of the literature. Namely, it appears that the factor-only model fails to account for all the variance of output. However, the key finding of table 2 appears when comparing the results obtained with official

[9] Note that we do not adjust input figures. The main reason for that is that we are not aware of estimates of the labor force and the capital stock in the shadow economy for a large enough sample of countries. We will, however, argue in the section on robustness checks that such correction would not greatly affect our results, and, if anything, would likely make them stronger.

figures to those obtained with corrected figures. We thus observe that the measures of success of the factor-only model are substantially greater when corrected figures are used instead of official figures. In our sample, the correction adds around twenty percentage points to those measures.

Table 3: Descriptive statistics of implied productivity

	Mean	Standard deviation	Max/Min
A	2.559	0.699	4.708
A_{tot}	3.337	0.913	4.584

A stands for TFP computed using official figures. A_{tot} denotes TFP computed with figures corrected for the shadow economy.

Table 3 above provides more information on the impact of adding the shadow economy to official output figures. The distribution of official TFPs is described in the first line and the distribution of corrected TFPs (including the shadow economy) in the following line. The results of table 3 are reminiscent of those in table 1. Namely, it appears that both the mean and the standard deviation of TFPs increase when the shadow economy is taken into account. However, the distribution of TFPs becomes more concentrated around its mean, as the drop in the ratio of maximum to minimum TFP suggests. Here again, the rationale for this result stems from the fact that a smaller share of output is officially reported in poorer countries. Their TFP therefore stands to be relatively more underestimated than that of richer countries. As a result, correcting for the shadow economy leads to a more concentrated distribution of TFP.

Table 4: Productivity calculations: ratios to U.S. values

Country	y	y_{tot}	A	A_{tot}
USA	1	1	1	1
Norway	0.953	1.044	0.859	0.941
Singapore	0.876	0.911	0.854	0.889
France	0.824	0.873	0.914	0.968
Italy	0.758	0.886	0.915	1.070
Hong-Kong	0.750	0.804	0.905	0.970
Canada	0.743	0.793	0.823	0.878
Great Britain	0.734	0.761	0.978	1.014

Japan	0.664	0.680	0.655	0.671
Argentina	0.417	0.481	0.821	0.947
Mexico	0.293	0.350	0.763	0.913
Brazil	0.231	0.297	0.725	0.933
Egypt	0.178	0.221	1.226	1.524
Philippines	0.138	0.182	0.623	0.822
China	0.100	0.103	0.510	0.529
India	0.090	0.102	0.727	0.823
Kenya	0.037	0.045	0.455	0.563
Malawi	0.026	0.034	0.551	0.711
Mean	0.340	0.384	0.765	0.918
Correlation with y	1	0.995	0.435	0.140

y denotes official output per worker and y_{tot} total output per worker defined as official output plus the shadow economy. A stands for TFP computed using official figures. A_{tot} denotes TFP computed with figures corrected for the shadow economy.

To illustrate those results, table 4 picks some countries from the sample, and displays their official incomes, total incomes, and productivities. To facilitate comparisons, all values are given relative to the U.S., and countries are ranked by decreasing official GDP per worker. Table 4 also recalls summary statistics for the entire sample, and the correlation of each displayed variable with official output per worker.

Table 4 confirms that productivity differences are responsible for the bulk of differences in output per worker. The same diagnosis can be made regardless of the definition of output, official or corrected, used for computations. Table 4, however, shows that the rise in output due to the inclusion of the shadow economy can indeed be quite large for some countries, and especially poorer ones. The result is that total productivity can be severely underestimated in countries with a large shadow sector. For instance, Malawi's official productivity is 55.1% of the US. However, when corrected figures are used instead of official ones, Malawi's TFP relative to the US increases by 20 percentage points. A similar order of magnitude can be found in a middle-income country like Brazil, where overall TFP exceeds official TFP by 20.8 percentage points relative to the US. Its GDP thus becomes 93.3% of the US instead of 72.5%.

Even among developed countries can the inclusion of the shadow economy affect our perception of TFP differences, although its absolute increase remains smaller. Countries like Italy or Great Britain can thus make up all their difference vis-à-vis the US, as the upper half of table 4 shows.

More generally, all the variables displayed in table 4 appear to be positively correlated with official output per worker. Richer countries also tend to be more productive. More remarkable, however, is the fact that the correlation of TFP with output decreases when the shadow output is added to official output. The intuition of that finding is that the share of the shadow economy tends to increase when income decreases. Poorer countries therefore report a smaller fraction of their total output. This introduces a systematic bias that results in underestimating TFP in poor countries, which increases the correlation between output and TFP. When this statistical artifact is corrected, the correlation between output and TFP consequently becomes less clear. This is precisely what our calculations reveal.

These results may cast some doubt on the usual finding that the quality of institutions is positively correlated with productivity, because the observed relationship may also be driven by unreported output. The next section investigates this possibility.

4. Do institutions really affect output and productivity after all?

Our chief measure of institutional quality is the rule of law, which has been an important focus of the literature on institutions and economic performance, such as Rodrik et al. (2004), or Dollar and Kraay (2003). It is measured by the World Bank's rule of law index (Kaufman et al. 2006) for the year 2000. This index measures whether and to what extent institutions protect property rights, and reliably enforced laws and regulations govern economic and social interactions. It is based on perceptions recorded in a large number of independent polls and surveys.

As a first step, we see whether we can replicate previous results on the impact of the rule of law on the underground economy with our sample. We chose a parsimonious model, including per capita GDP as the only additional explanatory variable. Table A1 in the appendix presents the results. As can be seen, GDP per capita does not affect the share of the underground economy at conventional levels of significance. The result, however, confirms previous research showing that institutions are negatively related to the shadow economy. At the one percent level of significance, a better rule of law reduces the share of the shadow economy. Specifically, an increase in the rule of law index by one point reduces the shadow economy by 0.3 percentage points.[10] This amounts to a standardized beta coefficient of almost 0.8. This result for 133 countries is in line with the models of Johnson et al. (1997) and Hindriks et al. (1999) and the results reported in Johnson et al. (1997, 1998b) showing that corruption affects the shadow economy positively in a cross section of 15 and, respectively,

[10] This index is measured on a –2.5 to 2.5 scale. It ranges from –2.37 to 2.11 in our sample.

39 countries. We proceed by examining the impact of institutions on official and unofficial (logged) output per worker.

Table 5: Institutions and output, year 2000

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Number of countries	133	133	124	124
Dependent variable	Official output	Total output	Official output	Total output
Rule of Law	0.93	0.86	1.31	1.23
	(19.53)***	(17.93)***	(11.20)***	(10.66)***
R-squared	0.64	0.60	0.54	0.50
First-stage F-test			36.52	36.52
Sargan test (P-value)			0.14	0.11

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Constant term included but not reported.

Table 5 shows the results. Again, we follow Hall and Jones (1999) and opt for a parsimonious specification, including only the rule of law as explanatory variable. As Hall and Jones (1999) argue, social infrastructure, that is institutions, is the primary and fundamental determinant of output per worker.

While column 1 refers to official GDP, column 2 employs corrected output figures, i.e. overall output including the shadow economy. Given the negative impact of the rule of law on the shadow economy (reproduced for our sample in table A1 in the appendix), we would expect the impact of the rule of law on output to be smaller or vanish completely once the underground economy is included. As can be seen, this is indeed what happens. The results show that the impact of the rule of law on total output is smaller than its impact on official output. Our results show that improvements in the rule of law still increase output when the shadow economy is taken into account – the positive impact on official GDP apparently dominates the negative impact on the size of the shadow economy. According to the coefficients, an increase in the rule of law index by one point increases official output by 9.3 percent, while increasing total output by 8.6 percent only. With the rule of law index varying from -2.37 to 2.11 among the countries included in our sample, the difference between the parameters of the two models is non-negligible. It is significant at the one percent level. The standardized regression (beta) coefficients are 0.8 and 0.78, respectively.

As one potential problem with the analysis, however, institutions might well depend on GDP and could as such be endogenous. To control for potential endogeneity bias, we instrument the rule of law index employing the variables suggested in Hall and Jones (1999) as instruments for institutional quality. Their instruments measure the extent of Western influence in the sixteenth trough nineteenth century, being exogenous to GDP, but being highly correlated with institutions. According to Hall and Jones, European influence is unlikely to have been stronger in regions more likely to have higher GDP today. This is, first, because Europeans were conquering above all resource rich regions, which are not systematically among the countries with high output per worker today. Second, European influence concentrated on sparsely settled regions. As these frequently were regions with low productivity, there should again be no tendency for these regions to be among those with high output per worker today.

Still, past European influence is likely to be highly correlated with the rule of law. As Hall and Jones (1999) point out, countries most strongly influenced by Western Europe are among those most likely to adopt favorable infrastructure. We employ the percentage of a country's population speaking one of the five primary Western European languages as their mother tongue. In addition, we use the absolute value of a country's latitude in degrees, measuring the distance from the equator.[11]

Columns 3 and 4 of Table 5 report the results of our instrumental variables approach. As shown in the table, the overidentifying restrictions are not rejected at conventional levels of significance. The instruments are jointly significant at the one percent level in both first-stage regressions. In fact, the F-test statistic easily exceeds the rule-of-thumb threshold of 10 proposed by Staiger and Stock (1997), indicating some power of the instruments.

As can be seen, the impact of the rule of law on output remains significant at the one percent level in both specifications, with a positive coefficient. The coefficients show that an increase in the rule of law index by 0.01 increases official output by 13.1 percent, and total output by 12.3 percent. Again, the impact of the rule of law is thus smaller when focusing on total output as compared to official output. The difference in parameters of the two models is significant at the five percent level.

[11] Hall and Jones provide two plausible motivations for this: First, Western European settlers were more likely to migrate to sparsely populated areas in the fifteenth century. Second, they were more likely to settle in regions with climate similar to Western Europe, which is true for regions far from the equator.

Table 6a: Institutions and Total Factor Productivity, 76 countries, year 2000

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Dependent variable	Official TFP	Total TFP	Official TFP	Total TFP
Rule of Law	0.25	0.07	0.24	0.04
	(3.91)***	(0.83)	(3.49)***	(0.38)
R-squared	0.15	0.01	0.15	0.01
First-stage F-test			116.55	116.55
Sargan test (P-value)			0.92	0.98

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Constant term included but not reported.

Table 6b: Institutions and Total Factor Productivity, 76 countries, year 2000

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Dependent variable	Official TFP	Total TFP	Official TFP	Total TFP
Rule of Law	0.24	0.05	0.22	-0.01
	(2.80)***	(0.42)	(2.24)**	(0.10)
Government consumption	-0.006	-0.006	-0.005	0.001
(percent of GDP)	(0.35)	(0.25)	(0.23)	(0.04)
Inflation	-0.01	-0.01	-0.01	-0.01
	(2.44)**	(2.32)**	(2.51)**	(2.48)**
R-squared	0.18	0.04	0.18	0.04
First-stage F-test			70.41	70.41
Sargan test (P-value)			0.86	0.97

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Constant term included but not reported.

Tables 6a and 6b focus on total factor productivity. When instrumenting institutional quality with latitude and the percentage of major European languages spoken, the Sargan test does reject the overidentifying restrictions, casting doubts on the exogeneity of the instruments. The analysis presented in the table therefore employs the share of native English speakers instead of focusing on five languages (as suggested by Hall and Jones 1999) and GDP per capita.

It now appears that while the rule of law is highly correlated with per capita GDP, it is not significantly correlated with total factor productivity (0.84 and, respectively, 0.3). This suggests that the impact of institutions on output runs mainly through factor endowments as opposed to productivity. While the results are not affected by the choice of instruments, the Sargan test does now not reject the overidentifying restrictions at conventional levels of significance.

We present two sets of results. First, table 6a again employs a parsimonious model, including the rule of law index as the only explanatory variable. Second, in table 6b we additionally control for government consumption (in percent of GDP) and the rate of inflation. Both variables create distortions and can thus reasonably be expected to affect the relationship between the rule of law and factor productivity.

According to the results of both specifications, the rule of law significantly increases total factor productivity when official output is concerned. However, turning to total output, this result no longer holds. According to the OLS and instrumental variables estimates, the impact of the rule of law on total factor productivity no longer exists once controlled for the shadow economy. This result has important implications for empirical research on the impact of institutional quality on productivity. While good institutions increase official output, they at the same time decrease the size of the underground economy. As a consequence, total factor productivity does not seem to be affected by the quality of institutions. Regarding the control variables, table 6b shows that government consumption does not affect factor productivity in any specification, while productivity declines with inflation, at the five percent level of significance. The first-stage F-test indicates some power of the instruments, while the Sargan test does not reject the overidentifying restrictions at conventional levels of significance. Overall, these results suggest a new implication of the results obtained for instance by Hall and Jones (1999) or Lambsdorff (2003). Their finding that the quality of institutions affects official productivity may indeed be driven by the fact that they used official figures, and therefore underestimated output. Consequently, their estimates may not only imply that some production disappears in weak institutional frameworks, but also that some production goes underground.

Table 7 decomposes the effect of institutional quality on the components of total output. Total output being equal to official output plus the shadow economy, expression (2) implies that the sum of the coefficients of institutions that appear in columns (2) to (5) of table 7 should equal the coefficient that appears in the first column.[12]

[12] This comes from the definition of total output as y_{tot} = (1+shadow)*y = (1+shadow)*$AK^{\alpha}h^{1-\alpha}$.

Table 7: Decomposing the impact of institutions on total output, 2SLS, 76 countries, year 2000

Dependent variable	(1) log y	(2) α log k	(3) (1-α) log h	(4) log tfp	(5) log (1+shadow)
Rule of Law	0.99	0.83	0.10	0.14	-0.09
	(11.17)***	(9.85)***	(9.54)***	(3.32)***	(9.59)***
R-squared	0.64	0.63	0.60	0.16	0.54
First-stage F-test	42.16	42.16	42.16	42.16	42.16
Sargan test (P-value)	0.00	0.06	0.14	0.06	0.11

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Constant term included but not reported.

According to Table 7, total output increases with the rule of law at the one percent level of significance in the restricted sample of 76 countries, confirming the results of Table 5. The results also show that the impact of institutional quality on total output runs through its effect on physical capital, human capital, and TFP, but is partly compensated by its impact on the shadow economy. They, however, also imply that the by far biggest share of the impact of institutional quality on output is via the capital stock per worker.

5. Further discussion and tests for robustness

It may be argued that the concept of institutions is multifaceted, and that our results lack generality because we only focused on one indicator of institutional quality. As our first test of robustness, we therefore check whether our main results hold when using alternative indicators of institutional quality. We replicate the analyses displayed in tables 5 and 6a with alternative governance measures constructed by the World Bank (Kaufman et al., 2006). The World Bank's control of corruption index is an aggregate measure of the extent of corruption (defined as the exercise of public power for private gain). Voice and accountability refers to the extent to which a country's citizens can participate in selecting their governments, and to freedom of expression, association and the media. Political stability captures a population's perception of its government's stability. It is the perceived likelihood that the government could be overthrown by violent or unconstitutional means. Government effectiveness reflects the quality of the administration and of civil servants, and the credibility of a government. It focuses on inputs that governments need to produce and implement sound policies and deliver public goods. Regulatory quality measures the government's ability to formulate and implement sound and market-friendly policies and regulations.

Table A2 in the appendix shows the impact of the additional five indicators of institutional quality on official and total output. According to all (OLS and 2SLS) regressions, institutional quality increases official and total output at the one percent level of significance. According to all regressions, moreover, the coefficients of the institutional variables become smaller when official output is corrected for the size of the shadow economy. In all regressions, the difference between the parameters of the two models is significant at the five percent level at least.

Table A3 in the appendix shows how the choice of indicator affects the results for the impact of institutional quality on total factor productivity. As can be seen, the general picture is consistent with the results reported for the rule of law above. Focusing on the 2SLS results, better institutions increase official factor productivity in all regressions, at the one percent level of significance. Correcting for the size of the shadow economy, none of the coefficients remains significant at conventional levels. If one interprets those indicators as proxies for the same underlying phenomenon, one may conclude that our main results are robust to the choice of indicator of institutional quality. If one considers that those indicators measure different dimensions of the institutional framework,[13] one may also consider the differences in the magnitudes of the coefficients. They suggest that it is the quality of the regulatory framework and the voice and accountability indicators that have the largest impact.

One may also argue that the relationship may differ according to countries' development, because they operate in different economic and political environments. Our second test thus consists in splitting the sample according to income. Our high-income sample contains countries with per capita GDP above 6000 US$, which is the average value among our sample of countries. The low-income sample includes those with values below 6000 US$.

Tables A4 and A5 in the appendix show the results according to income groups. As can be seen in table A4, the results for the low-income group very much resemble those for the previous sample. Again, official and total output increase significantly with the rule of law; again, the coefficient declines in magnitude once accounted for the shadow economy. In the group of countries with high income, there is a substantial decline in the magnitude of the impact of the rule of law on output when we take account of the shadow economy. In the 2SLS regressions, however, the impact of the rule of law is no longer significant at conventional levels. The small number of countries does not seem to allow the identification of a significant impact here.

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[13] See Bjørnskov (2006) for a discussion of whether and to what extent these indices can be separated statistically rather than representing the same underlying concept.

According to table A5, the previous results regarding total factor productivity hold for the sample of 50 low-income countries, while neither official nor total productivity are affected in the sample of 26 countries with above average per capita GDP. This suggests that the relationship that was previously observed was mainly driven by low-income countries.

We also replicate the analysis of total factor productivity setting α to 0.6 and, respectively, 0.3, which can be considered as extreme values for the share of capital suggested in the previous literature. While it is well known that the results of development accounting severely depend on the choice of α, and we consider the mean value of 0.57 to be the appropriate one for our sample of countries, this provides an interesting test for the robustness of our results.

Table A5 in the appendix shows that using a value of 0.6 confirms the results obtained previously. Employing a value of 0.3, the results also show that improving the rule of law significantly increases official productivity. However, the magnitude of the coefficient is significantly larger than with higher values of α. More to the point, and contrary to the results obtained above, productivity remains correlated with the rule of law, at the one percent level of significance even when the shadow economy is added to output. The rationale for this result is that decreasing α reduces the role of the physical capital stock in explaining TFP differences. As the variance of the physical capital stock is larger than the variance of the human capital stock, this leaves a larger fraction of the variation of output unexplained by factor endowments. Moreover, as table 7 shows, the impact of institutions on output mainly goes through its impact on capital. As a result, using a lower α increases not only the Solow residual but also its correlation with institutions. Unsurprisingly therefore, the regression's R^2 when TFP is regressed on institutions is larger when α is 0.3. It simply reflects the fact that the impact of institutions on the capital stock is partly neglected when TFP is computed with a small α, which overstates the correlation between institutions and productivity. This result notwithstanding, one should, however, notice that the coefficient of the rule of law index diminishes when total output is used to compute TFP instead of official output. This therefore again suggests a substitution of shadow output to official output when the institutional framework deteriorates.

The impact of not correcting input figures for the shadow economy also deserves some comments. This concern first hinges on labor figures. Following the rest of the development accounting literature, we proxy the labor force by the working age population. There is therefore no reason to correct those figures for the shadow economy, unless one suspects the existence of "shadow inhabitants." Admittedly, the ideal concept of labor inputs would be the number of hours worked. Unfortunately, figures on the number of worked hours are scarce, let alone figures on hours worked in the shadow economy. At the same time, with the limited data available, Caselli (2005) shows that taking into account differences in hours worked is unlikely to affect the outcome of development accounting analyses. Not adjusting labor inputs should therefore prove of little importance for our results.

The same concern holds for the capital stock, which we do not correct for the shadow economy either.[14] This concern deserves several comments. First, ever since the ILO's (1972) seminal study of the informal sector, it has been stressed that small scale activities dominate that sector, at least in developing economies, and that it therefore generates low income and little accumulation, if any, as Gërxhani (2004) points out. Loayza (1996) even views the lack of capital as an intrinsic consequence of the nature of the informal sector: Since informal firms must avoid detection, and face prohibitive borrowing rates because they cannot sign formal contracts, the value of informal capital is inevitably limited. Furthermore, the capital stock used in the shadow economy might simply be that of the official sector. As Tanzi (1999) remarks, individuals who operate in the shadow economy often use capital or tools that are borrowed from the official economy. Hillman et al. (1995) back this claim with anecdotal evidence from Bulgaria. They report that formal state enterprises were rented out to informal entrepreneurs. This implies that there may be little capital specific to the shadow economy.

This first remark notwithstanding, one may still worry that some unregistered capital operates in the shadow economy. As the shadow economy is larger in poorer countries, and in countries with poorer institutions, this may result in overestimating TFP in those countries. At the same time, as Pritchett (2003) argues, those countries are also those where public investment is the least efficient. Those countries moreover experience more frequent destructions due to natural disasters, as Caselli and Malhotra (2004) emphasize, and wars. The perpetual inventory method, which does not control for the efficiency of investment, and assumes a constant rate of depreciation across countries, thus overestimates poor and badly governed countries' capital stocks, and underestimates their TFPs. Given the scale of public investments compared to the scale of activities in the shadow economy, one may contend that the latter effect is bound to dominate the former. Therefore, there are reasons to believe that

[14] In fact, the appropriate measurement of the capital stock is a general preoccupation of the development accounting literature.

more accurate measures of the capital stock would further weaken the link between institutional quality and TFP, thus strengthening our findings.[15]

Finally, it is important to test whether our results depend on how we measure the size of the shadow economy. While the data used here refer to a larger number of countries than any other available data and are consistently estimated employing the same method for all countries, other estimates are also available. As our final test for robustness, we replicate the analysis using five different sets of estimates for the shadow economy. Two indicators are taken from Friedman et al. (2000) who collected data on the unofficial economy for 69 countries from various sources. The first indicator is also used in Johnson et al. (1998) and relies on three different sources.[16] Their second set of estimates uses electricity-based estimates whenever available rather than the multiple causes, multiple indicators (MIMIC) and currency demand estimates.[17] The remaining three sets of estimates are taken from Schneider and Enste (2000). First, we use average estimates for the years 1990-93 employing the physical input (electricity) method. Second, we use their MIMIC estimates over the same period of time. Our third indicator complements the first with data over the years 1989-90 using the same method (taken from Johnson et al., 1997).

Table A7 in the appendix reports the results for the impact of the rule of law on official and total output, while table A8 replicates the previous analysis for factor productivity. As can be seen, our previous results are confirmed to some extent. For samples varying between 33 and 69 countries, all estimates confirm the decline in the impact of the rule of law on output once corrected for the shadow economy. However, again, all estimates stay significant at the ten percent level at least. Turning to Total Factor Productivity, the OLS results confirm the results reported above. While official output rises significantly with a better rule of law, this relationship is no longer significant once the underground economy is accounted for. However, when estimated with 2SLS, the previous positive impact of the rule

[15] One should also bear in mind that this concern only affects our findings on the relationship between TFP and institutions but not those on the relationship between output and institutions.

[16] Data for developed countries are calculated employing the currency demand method for the years 1990–1993. Data for transition countries use Johnson et al.'s (1997) estimates for 1995, while data for Latin America employ MIMIC estimates for 1990-1993 from Loayza (1996). Data for Asia and Africa are from Lacko (1996) and are based on the electricity method. See Appendix E for a short description of these methods and Schneider (2007) and Schneider and Enste (2000) for more details.

[17] More specifically, electricity-based estimates rather than MIMIC estimates are used for Latin America whenever available. For transition economies, 27 electricity-based estimates for the years 1990–1993 rather than for 1995 are used. Data for most developed countries are also calculated employing the electricity-based method (for the years 1989–1990).

of law no longer prevails. According to the results, the coefficients remain positive for official productivity, but turn negative for corrected productivity, which is again in line with our previous results. Due to the substantially reduced sample size, however, the coefficients are (in some cases marginally) insignificant.

To summarize, our results are very robust regarding the indicator of institutional quality and how we measure the size of the shadow economy. In line with the previous literature, we find, however, that our main results to some extent depend on the choice of α, the contribution of capital to output. While our results hold when employing a reasonable upper bound of α of 0.6, they do not hold when setting α to 0.3, which is the long run average for the US (but clearly inappropriate as average value for the countries among our sample).

6. Concluding Remarks

In this paper, we re-examined the nexus between output, productivity, and institutions, while taking account of the importance of the shadow economy across the world. With that end in view, we studied the distribution and institutional determinants of output and total factor productivity (TPF), and compared the results obtained with official output and total output, defined as the sum of output produced in the official and shadow economy.

According to our results, the distribution of output becomes less dispersed when official output figures are corrected for the shadow economy. This is due to the fact that the share of unrecorded activity is larger in poorer countries. Those countries' total production therefore tends to be underestimated by official figures.

To check how the omission of the shadow economy from official output figures may bias productivity measures, we performed a development accounting analysis with both official and corrected output figures. Our results show that using official figures underestimates total factor productivity, especially in poor countries. Moreover, we observe that correcting output for the shadow economy leads to an increase in the predictive power of the factor-only model. Part of the puzzle of the limited ability of factor-endowments to explain cross-country differences in output per worker may thus be explained by the existence of the shadow economy.

To move to a deeper level of explanation of differences in countries' economic performance, we studied the impact of the quality of the institutional framework. While we could replicate the usual association of output and TFP with institutions when we used official figures, we obtained more qualified results once employing corrected output figures. Namely, although total output is significantly positively correlated with institutional quality, the estimated impact of institutions is smaller than the one obtained with official output. Even more striking is the impact of our correction on the relationship between TFP and institutions. More specifically, even though we observe the usual positive correlation between TFP and institutional quality when output is measured by official figures, this correlation loses significance when corrected output is used instead. This finding survived a series of robustness checks. In the least, our result calls for a reinterpretation of earlier studies that have emphasized the relationship between measured TFP and institutional quality. Our results suggest that part of the observed relationship reported in the previous literature is not due to a reduction of output, but instead due to a switch to the informal sector.

Our results have broad implications for the empirical literature on the determinants and consequences of GDP. Since the shadow economy tends to be higher in countries with lower official GDP, results employing uncorrected figures will reflect this bias. Whenever the interest of the researcher is on income, instead of official income, corrected figures should be used instead of the official ones.

What our results underline at the same time is that development accounting is a powerful tool of analysis that still needs improvement. This paves the way for future exciting research that may still change our understanding of the determinants of countries' relative economic performance around the world.

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Appendix

Appendix A: Regression results

Table A1: Rule of Law and shadow economy, 133 countries, year 2000

	(1)
Official output p.c. (log)	-0.03
	(1.00)
Rule of Law	-0.32
	(7.86)***
R-squared	0.58

Notes: Robust t statistics in parentheses; *** significant at 1%.

Constant term included.

Table A2: Institutions and output, year 2000

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Number of countries	133	133	124	124
Dependent variable	Official output	Total output	Official output	Total output
Control of corruption	0.84	0.77	1.28	1.21
	(17.28)***	(16.21)***	(9.74)***	(9.33)***
R-squared	0.57	0.54	0.40	0.35
First-stage F-test			32.32	32.32
Sargan test (P-value)			0.37	0.30
Voice and accountability	0.77	0.73	1.28	1.21
	(10.46)***	(10.39)***	(10.81)***	(10.82)***
R-squared	0.38	0.38	0.21	0.21
First-stage F-test			52.48	52.48
Sargan test (P-value)			0.24	0.30
Political stability	0.79	0.73	1.38	1.30
	(10.86)***	(10.42)***	(9.96)***	(9.72)***
R-squared	0.44	0.41	0.18	0.14
First-stage F-test			36.05	36.05
Sargan test (P-value)			0.55	0.47
Government effectiveness	0.90	0.82	1.34	1.26
	(18.00)***	(16.69)***	(10.44)***	(9.97)***
R-squared	0.59	0.55	0.44	0.40
First-stage F-test			34.99	34.99
Sargan test (P-value)			0.57	0.47
Regulatory Quality	0.82	0.76	1.67	1.59
	(7.76)***	(7.40)***	(9.47)***	(9.27)***
R-squared	0.40	0.38	0.12	0.09
First-stage F-test			25.79	25.79
Sargan test (P-value)			0.01	0.02

Notes: Robust t statistics in parentheses; *** significant at 1%.

Constant term included but not reported.

Table A3: Institutions and Total Factor Productivity, 76 countries, year 2000

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Dependent variable	Official TFP	Total TFP	Official TFP	Total TFP
Control of corruption	0.23	0.08	0.23	0.03
	(3.95)***	(0.99)	(3.46)***	(0.38)
R-squared	0.14	0.01	0.14	0.01
First-stage F-test			79.06	79.06
Sargan test (P-value)			0.91	0.99
Voice and accountability	0.22	0.12	0.38	0.06
	(2.52)**	(1.01)	(3.65)***	(0.39)
R-squared	0.08	0.01	0.17	0.01
First-stage F-test			28.64	28.64
Sargan test (P-value)			0.99	0.99
Political stability	0.20	0.06	0.32	0.05
	(2.65)***	(0.55)	(3.32)***	(0.37)
R-squared	0.08	0.00	0.05	0.00
First-stage F-test			28.98	28.98
Sargan test (P-value)			0.93	0.98
Government effectiveness	0.32	0.17	0.26	0.04
	(5.17)***	(1.95)*	(3.73)***	(0.39)
R-squared	0.22	0.04	0.22	0.02
First-stage F-test			65.34	65.34
Sargan test (P-value)			0.91	0.99
Regulatory Quality	0.36	0.26	0.38	0.06
	(4.64)***	(2.37)**	(3.65)***	(0.41)
R-squared	0.17	0.05	0.17	0.02
First-stage F-test			28.64	28.64
Sargan test (P-value)			0.63	0.99

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Constant term included but not reported.

Table A4: Institutions and Output by income, year 2000

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Dependent variable	Official output	Total output	Official output	Total output
Low income countries				
Rule of Law	0.82	0.76	2.61	2.54
	(8.20)***	(7.55)***	(3.85)***	(3.77)***
Number of countries	101	101	93	93
R-squared	0.28	0.25	.	.
First-stage F-test			7.63	7.63
Sargan test (P-value)			0.07	0.05
High income countries				
Rule of Law	0.28	0.19	0.00	-0.04
	(3.57)***	(2.88)***	(0.02)	(0.27)
Number of countries	32	32	31	31
R-squared	0.38	0.26	.	.
First-stage F-test			2.24	2.24
Sargan test (P-value)			0.32	0.20

Notes: Robust t statistics in parentheses; *** significant at 1%.

Constant term included but not reported.

Table A5: Institutions and Total Factor Productivity by income, year 2000

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Dependent variable	Official TFP	Total TFP	Official TFP	Total TFP
Low income countries				
Rule of Law	0.40	0.35	0.68	0.62
	(1.81)*	(1.18)	(2.34)**	(1.55)
Number of countries	50	50	50	50
R-squared	0.07	0.03	0.03	0.01
First-stage F-test			10.13	10.13
Sargan test (P-value)			0.38	0.26
High income countries				
Rule of Law	0.07	-0.13	0.17	-0.11
	(0.57)	(1.35)	(0.84)	(0.83)
Number of countries	26	26	26	26
R-squared	0.01		0.05	0.05
First-stage F-test			12.58	12.58
Sargan test (P-value)			0.20	0.24

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%. Constant term included but not reported.

Table A6: Rule of Law and Total Factor Productivity by α, 76 countries, year 2000

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Dependent variable	Official TFP	Total TFP	Official TFP	Total TFP
α=0.6				
Rule of Law	0.11	-0.02	0.10	-0.05
	(2.61)**	(0.28)	(2.19)**	(0.79)
R-squared	0.07	0.00	0.07	.
First-stage F-test			116.55	116.55
Sargan test (P-value)			0.90	0.96
α=0.3				
Rule of Law	32.27	31.02	34.42	32.57
	(11.45)***	(8.49)***	(11.18)***	(8.33)***
R-squared	0.62	0.46	0.62	0.46
First-stage F-test			116.55	116.55
Sargan test (P-value)			0.72	0.63

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Constant term included but not reported.

Table A7: Rule of Law and Output, different estimates for shadow economy

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Dependent variable	Official output	Total output	Official output	Total output
Friedman et al. (2000) set 1	0.67	0.58	0.89	0.73
	(13.23)***	(12.49)***	(5.34)***	(4.47)***
R-squared	0.71	0.67	0.67	0.64
Number of countries	69	69	65	65
First-stage F-test			9.35	9.35
Sargan test (P-value)			0.18	0.20
Friedman et al. (2000) set 2	0.67	0.61	0.89	0.76
	(13.23)***	(13.32)***	(5.34)***	(4.70)***
R-squared	0.71	0.70	0.67	0.68
Number of countries	69	69	65	65
First-stage F-test			9.35	9.35
Sargan test (P-value)			0.13	0.20
Physical input method	0.71	0.62	0.79	0.69
	(10.89)***	(10.22)***	(7.58)***	(6.81)***
R-squared	0.71	0.66	0.70	0.65
Number of countries	54	54	54	54
First-stage F-test			32.49	32.49
Sargan test (P-value)			0.07	0.05
MIMIC	0.74	0.65	0.56	0.46
	(6.87)***	(6.66)***	(2.25)**	(1.91)*
R-squared	0.49	0.44	0.46	0.40
Number of countries	33	33	33	33
First-stage F-test			3.65	3.65
Sargan test (P-value)			0.02	0.01
Physical input method (extended)	0.67	0.62	0.90	0.76
	(14.13)***	(14.21)***	(5.66)***	(4.99)***
R-squared	0.71	0.69	0.65	0.66
Number of countries	75	75	68	68
First-stage F-test			10.28	10.28
Sargan test (P-value)			0.08	0.24

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Constant term included but not reported.

Table A8: Rule of Law and Total Factor Productivity, different estimates for shadow economy

	(1)	(2)	(3)	(4)
Method	OLS	OLS	2SLS	2SLS
Dependent variable	Official TFP	Total TFP	Official TFP	Total TFP
Friedman et al. (2000) set 1	0.20	-0.12	0.14	-0.25
	(2.27)**	(0.90)	(1.24)	(1.65)
R-squared	0.09	0.02	0.08	
Number of countries	45	45	45	45
First-stage F-test			53.11	53.11
Sargan test (P-value)			0.36	0.51
Friedman et al. (2000) set 2	0.20	-0.06	0.14	-0.19
	(2.27)**	(0.38)	(1.24)	(1.14)
R-squared	0.09	0.00	0.08	
Number of countries	45	45	45	45
First-stage F-test			53.11	53.11
Sargan test (P-value)			0.48	0.36
Physical input method	0.16	-0.13	0.12	-0.22
	(1.83)*	(0.91)	(1.09)	(1.38)
R-squared	0.06	0.02	0.06	0.01
Number of countries	47	47	47	47
First-stage F-test			53.50	53.50
Sargan test (P-value)			0.36	0.32
MIMIC	0.35	0.14	0.22	-0.11
	(1.95)*	(0.58)	(1.42)	(0.48)
R-squared	0.11	0.01	0.10	
Number of countries	27	27	27	27
First-stage F-test			10.77	10.77
Sargan test (P-value)			0.68	0.58
Physical input method (extended)	0.19	-0.08	0.13	-0.19
	(2.11)**	(0.59)	(1.26)	(1.21)
R-squared	0.08	0.01	0.07	
Number of countries	48	48	48	48
First-stage F-test			54.64	54.64
Sargan test (P-value)			0.66	0.54

Notes: Robust t statistics in parentheses; * significant at 10%; ** significant at 5%. Constant term included but not reported.

Appendix B: Sources and Definitions

Variable	Description	Source
Official output per worker (y)	Official output per worker measured in PPP dollars.	Penn World Tables version 6.2
Shadow economy (*shadow*)	Size of the shadow economy in percent of official GDP.	Schneider (2005)
Total output per worker (y_{tot})	Official output corrected for the share of the shadow economy.	
Number of workers (L)	Computed as rgdpch*pop*1000/rgdpwok.	Penn World Tables version 6.2
Investment (I)	Computed as rgdpl*pop*ki.	Penn World Tables version 6.2
Initial capital stock (K_0)	Estimated as $K_0 = I_0/(g + \delta)$.	Penn World Tables version 6.2
Capital stock (K)	Computed as $K_t = K_{t-1} * (1-\delta) + I_{t-1}$.	
Schooling (s)	Average number of years of schooling in the population over 25 years old	Barro and Lee (2001)
Human capital (h)	Defined as $h = e^{\phi(s)}$ where ϕ is a piecewise linear function.	
Latitude	Distance in degrees from the equator.	Easterly and Sewadeh (2001)
Language	Percentage of the population speaking one of the five primary European languages: Portuguese, Spanish, English, French, German.	Alesina et al. (2003)
Rule of Law	Perceptions based index, with higher numbers showing "better" environments.	Kaufman et al. (2006)
Corruption	Perceptions based index, with higher numbers showing "better" environments.	Kaufman et al. (2006)
Government Effectiveness	Perceptions based index, with higher numbers showing "better" environments.	Kaufman et al. (2006)
Quality of bureaucracy	Perceptions based index, with higher numbers showing "better" environments.	Kaufman et al. (2006)
Voice and Accountability	Perceptions based index, with higher numbers showing "better" environments.	Kaufman et al. (2006)
GDP per capita	GDP per capita (constant 2000 US$).	World Bank (2006)
Government consumption	General government final consumption expenditure in percent of GDP.	World Bank (2006)
Inflation	Inflation, consumer prices (annual percent)	World Bank (2006)

Appendix C: Descriptive Statistics

Variable	Mean	Minimum	Maximum	Standard Deviation
Official output per worker (log)	9.34	6.79	11.65	1.17
Shadow economy (percent)	33.46	8.60	67.10	12.87
Total output per worker (log)	9.57	7.18	11.26	1.09
Number of workers	16800000	29751	755000000	68000000
Capital stock	83000000000000	117000000000	2030000000000000	252000000000000
Investment	5140000000000	305000000	236000000000000	21700000000000
Schooling	6.18	1.00	12.00	2.91
Human capital stock	2.15	1.11	3.42	0.59
Latitude	17.58	-36.89	64.22	23.70
Language (five primary)	22.85	0.00	100.00	38.59
Language (English)	9.17	0.00	100.00	26.49
Rule of Law	-0.09	2.37	2.11	-0.99
Corruption	-0.07	2.13	2.49	-1.00
Government Effectiveness	-0.05	2.34	2.33	-1.00
Political stability	-0.20	-2.93	1.52	1.01
Voice and Accountability	-0.06	2.24	1.52	-1.01
GDP per capita	6001	86	44758	9043
Government consumption	16.42	3.83	63.78	7.71
Inflation	13.25	3.85	550.01	-52.26

Appendix D: Estimations of the production function

Table D1: Cross-section estimates of the production function (2000)

	Sample	Dependent	*k*	*h*	*Int.*	
1.1	Whole sample	y	0.63287 (24.18) ***	0.36713 (14.03) ***	0.02779 (0.08)	N=76 F=980.11*** Adj.R^2=0.9289
1.2	Whole sample	y_{tot}	0.58227 (22.58) ***	0.41773 (16.20) ***	0.99568 (2.78) ***	N=76 F=886.09*** Adj.R^2=0.9219
1.3	Developing countries	y	0.57484 (12.62) ***	0.42516 (9.33) ***	0.76281 (1.27)	N=53 F=275.30** Adj.R^2=0.8406
1.4	Developing countries	y_{tot}	0.55747 (12.21) ***	0.44253 (9.69) ***	1.30911 (2.17) **	N=53 F=260.82*** Adj.R^2=0.8364
1.5	Developed countries	y	0.51573 (4.24)	0.48427 (3.98)	1.89131 (1.01)	N=23 F=20.42*** Adj.R^2=0.4689
1.6	Developed countries	y_{tot}	0.47065 (3.60) ***	0.52935 (4.05) ***	2.73685 (1.37)	N=23 F=8.38*** Adj.R^2=0.2511

Robust t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

We first estimated expression (2) on the cross-country sample that we use for development accounting. We first used official output then total output in our computations. We then split our sample between developing and developed countries according to the World Bank definition and ran our estimation anew. The results are displayed in table D1, in the fourth column of which the estimated value of is reported. Our estimates show that the share of capital is slightly below average in developed countries, but its estimate remains greater than 0.3. The average estimated coefficient in table D1 is $\alpha \cong 0.56$.

Table D2: Panel estimates of the production function (1980-2000)

	Sample	Method	*k*	*h*	*Int.*	
2.1	Whole sample	*Pooled*	0.608 (50.00) ***	0.392 (32.30 ***	0.401 (2.38) **	N=79 R^2=0.9172
2.2	Whole sample	*Between*	0.609 (23.70) ***	0.391 (15.19 ***	0.376 (1.06)	N=79 R^2=0.9270
2.3	Whole sample	*Fixed country effects*	0.525 (14.93) ***	0.475 (13.53 ***		N=79 R^2=0.9889 F=25.86
2.4	Whole sample	*Fixed country and time effects*	0.543 (15.73) ***	0.457 (13.23 ***		N=79 R^2=0.9896 F=26.32
2.5	Whole sample	*Random country effects*	0.578 (27.13) ***	0.422 (19.82 ***	0.811 (2.74) ***	N=79 R^2=0.7467 M=3.63
2.6	Whole sample	*Random country and time effects*	0.584 (27.95) ***	0.416 (19.94 ***	0.731 (2.51) **	N=79 R^2=0.7457 M=2.17

Robust t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Fixed effects are not reported.

Table D2 displays the results of our panel estimations. They were run on a sample of 79 countries and five years (1980, 1985, 1990, 1995, and 2000) for which we have data on both human and physical capital stocks. As the shadow economy data do not go sufficiently back in time, we had to focus on official output in our computations. F-tests support the existence of country-specific effects while Hausman tests accept the random one-way model, but marginally reject the random effect model. However the estimated values of α display little variation across estimations. The mean value of that parameter is $\alpha \cong 0.57$.

Appendix E: Methods to Estimate the Size of the Shadow Economy

The Currency Demand Approach

The currency demand approach employs a currency demand function to calculate the shadow economy. It is assumed that shadow transactions are undertaken in the form of cash payments, so as to leave no observable traces for the authorities. An increase in the size of the shadow economy will therefore increase the demand for currency. To isolate the resulting "excess" demand for currency, an equation for currency demand is estimated, controlling for variables like the development of income, payment habits, and interest rates, among others. Additionally, variables as direct and indirect tax burden, government regulation and the complexity of the tax system – which are assumed to be among the major factors causing people to work in the shadow economy – are included in the estimation equation. Any "excess" increase in currency, or the amount unexplained by the conventional or normal factors is then attributed to the shadow economy.

The Physical Input (Electricity Consumption) Method

This approach takes electric-power consumption as physical indicator of overall (or official plus unofficial) economic activity. Overall economic activity and electricity consumption have been empirically observed to move in lockstep, with an electricity to GDP elasticity usually close to one. This means that the growth of total electricity consumption is an indicator for growth of overall GDP. Subtracting the estimates of official GDP from this overall measure, unofficial GDP can be derived.

The Model Approach

The empirical method is based on the statistical theory of unobserved variables, which considers multiple causes and multiple indicators of the phenomenon to be measured. For the estimation, a factor-analytic approach is used to measure the hidden economy as an unobserved variable over time. The unknown coefficients are estimated in a set of structural equations within which the "unobserved" variable cannot be measured directly. The (DY)MIMIC – (dynamic) multiple-indicators multiple-causes – model consists in general of two parts, with the measurement model linking the unobserved variables to observed indicators.) The structural equations model specifies causal relationships among the unobserved variables. In this case, there is one unobserved variable – the size of the shadow economy – which is assumed to be influenced by a set of causes and indicators for the shadow economy's size.