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Abstract

To synthesize the literature on determinants of the shadow economy, this paper uses three cross-national shadow economy measures and employs numerous determinants over hundreds of model combinations to identify robust determinants of the shadow economy and address modeling uncertainty. We find that bureaucratic complexity is more significant than monetary severity in driving shadow activity. The incentives of new shadow entrepreneurs are somewhat different. A one standard deviation increase in tax complexity increases overall shadow economy by over ten percent of the mean. In contrast, a similar increase in business startup costs increases new informal entrepreneurs by almost more than double.

JEL-Codes: M130, H260, K420.

Keywords: shadow economy, robustness analysis, modeling uncertainty, entry barriers, development, taxes.

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1. Introduction

Shadow economies are widely prevalent across the globe, although various factors drive businesses to go underground.[1] Underground businesses are present even in nations that are otherwise quite law abiding (e.g., Scandinavian countries – see Schneider et al. (2010) and Tanzi (1982)). Such operations enable firms to evade taxes and regulations, although they must weigh these benefits against the potential costs of detection and punishment associated with breaking the law. Examples of underground businesses include unlicensed/unauthorized businesses, or businesses keeping transactions "off the books" to evade taxes. The prevalence of the underground sector is large around the globe. For example, Schneider (2012) reports that the shadow economy averaged nearly one-third of GDP (in 2006) for a large sample of developing and developed nations. In light of this, it is not surprising that policymakers seek effective means to counter the shadow economy to stem tax revenue leakages and to more effectively enforce laws and regulations. The policy challenge deals with both limiting entry into the shadow sector and controlling its spread. However, the extant literature considers a plethora of influences on the shadow sector, yet a set of consistent influences driving the underground economy have not been consistently identified. The present research aims to fill this void.

The theoretical literature has identified market entry costs (into the formal sector) as a significant barrier to entry of firms, inducing entrants to not enter the formal sector and to operate in the shadow (or underground) instead. Legal entry barriers (e.g., environmental regulations, licensing requirements, bureaucratic delays, etc.) have also been identified as key reasons for firms to operate underground (Gërxhani (2004), Schneider and Enste (2000)). These

[1] Shadow economies (or black or underground markets) are defined as economic activity that is unrecorded in the official accounts.

theoretical arguments on drivers of underground operations are intuitive; however, empirical verifications of the underlying hypotheses have had to rely on data that are at best imperfect measures of the institutional structure and the shadow economy.

Overall, the extant empirical literature has examined numerous determinants of the shadow economy, with many determinants showing mixed degrees of significance (see Gërxhani (2004), Schneider and Enste (2000)). Within the spectrum of different influences, the costs of market entry are arguably the most significant inducements to shadow entry, as they are perceived/incurred at the initial juncture when firms are contemplating entry or they have entered but are not yet fully established (e.g., signed a lease on the premises but do not yet have all the equipment, clearances, permits in place, etc.). However, the relative influence of various factors, including entry barriers, in driving the underground economy still remains unclear. This lack of consensus presents problems for the design of effective policies to check the growth of the underground sector.

A contributing factor behind these mixed results is that the literature has typically failed to consider the full spectrum of regulations (including business startup costs and procedures, property registration formalities and related costs and tax formalities and tax magnitudes), plus alternate measures of the shadow economy, partly because some of this information is relatively recent (e.g., see Djankov et al. (2002), Dreher and Schneider (2010), Gërxhani (2004), Schneider and Enste (2000)). In particular, the conclusion drawn regarding some factor of interest to the author may be dependent upon model specification and not robust to either (1) how the shadow economy is measured, or (2) the set of other potential shadow determinants that are controlled for in the empirical setup.

This paper uses a large sample of countries and several perspectives on the size of the underground economy to examine the effects of a whole range of potential economic and

institutional determinants of the prevalence of this phenomenon. Our approach will add to the literature on this topic and the conclusions drawn will be useful in informing public policy to contain the shadow sector. The key contributions to the literature include:

- studying the relative influence of a broad range of economic determinants and entry barriers on the prevalence of the shadow economy;
- understanding how the conclusions drawn by the empirical analysis are dependent upon how the shadow economy is measured. Given the difficulties with accurately measuring the shadow economy (see Frey and Weck-Hannemann (1984), Restrepo-Echavarria (2015), Schneider (2012), Schneider and Buehn (2013)), three alternate measures of its cross-national prevalence are used in this analysis to assess robustness of conclusions drawn;[2]
- analyzing the effects of economic prosperity on the prevalence of the underground economy. This is potentially important in light of the qualitative differences in the nature of the shadow economy across developed and developing nations; and
- to address underlying modeling uncertainty where the choice of determinants may be subject of researchers' (conscious or unconscious) bias, this paper employs a new approach to model robustness employing a novel econometric technique involving hundreds of model combinations to determine the statistical and economic robustness of shadow determinants across different shadow measures and model specifications.[3] The estimation technique enables us to address modeling uncertainty as well as sampling variability considerations. The framework also permits an analysis of which model

[2] Of the three measures of the shadow economy we consider (see Table 1), *Shadow1* and *Shadow2* are more comparable to each other, both with regard to each measuring the economy-wide prevalence of the underground sector and in the coverage of countries. On the other hand, *Shadow3* has about half the countries of the other two measures. We include *Shadow3* in the analysis as it provides a qualitatively different look at the shadow sector – namely, the entry of firms into the underground sector.

[3] This approach can be seen in the spirit of Leamer (1983), Sala-i-Martin (1997) and, more recently, Paldam (2015).

assumptions regarding control variables, if any, are key to obtaining the result for the coefficient of interest.

Results based on a unique robustness analysis of hundreds of model combinations show that business startup and property registration costs, and startup procedures significantly contribute to the relative importance of the shadow economy within the context of the overall economy. In regard to taxes, we find that it is tax code simplicity, rather than the tax rates or the overall level of taxation per se, that drive businesses to operate in the shadow. In other influences, greater economic prosperity turns out to be a robust check against shadow movements. Procedural simplicity turns out to be a robust path to control the growth of the shadow sector. With regard to the measurement of the shadow economy, the incentives of new shadow entrepreneurs to operate underground are somewhat different than those of other, established, shadow operators. This is partly because new operators are weighing relative costs of formal market entry against going underground and are discounting tax burdens that are farther down the road. Next, we discuss the alternate measures of the shadow economy employed.

2. Measures of the shadow economy

Given that underground operations are clandestine and hard to measure, especially when underground operators moonlight part time and are engaged in the provision of non-tangible goods and services (e.g., shadow moving companies, private cars operating as taxis, etc.), it is useful to focus on the sensitivity of findings to how the shadow sector is measured. Three alternative shadow economy measures are considered in this analysis, capturing qualitatively different dimensions and/or approaches to assess the significance of the underground sector. First, Schneider and associates have long estimated and refined measures of the cross-national

prevalence of the shadow economy. These measures have been widely used in the literature (for example, see Dreher and Schneider (2010)); however, there is a fundamental issue of unraveling information/incidence with trying to measure clandestine activities (Frey and Weck-Hannemann (1984), Restrepo-Echavarria (2015), Schneider and Buehn (2013)). In our analysis we use their recent measure of the prevalence of the shadow economy based on the Multiple Indicators Multiple Causes (MIMIC) method and call this *Shadow1*. In a nutshell, the MIMIC method links the unobservable shadow economy with the observable indicator variables (see Schneider (2012) and Schneider et al. (2010) for details).

Another measure of the shadow economy, *Shadow2*, based on the currency demand method has been recently be offered by Alm and Embaye (2013). The main idea behind this approach is that shadow operators would prefer cash transactions to keep transactions "off the books". Alm and Embaye's approach employs dynamic panel data methods to estimate currency demand and incorporates into the model measures of institutional quality, including a variable that serves as a proxy for the strength of tax enforcement efforts in each country. While one can argue that *Shadow1*, based on numerous causes and indicators, is somewhat broader than *Shadow2*. Hence both measures provide a useful robustness test about the shadow economy prevalence, an activity that is shrouded in secrecy and inherently difficult to measure.

Finally, a third measure, *Shadow3* by Autio and Fu (2015), addresses a qualitatively quite different dimension of the shadow economy – namely, the entry of new entrepreneurs into the shadow sector. In further contrast to the other two shadow size measures, their estimates for *Shadow3* are survey based as they combine data on entrepreneurship activity (both formal and informal) drawn from the Global Entrepreneurship Monitor (GEM) dataset by country with the World Bank Enterprise Snapshot data on formal incorporations. Their sample includes just over 60 developing and developed countries and is based on an average of new entrepreneurs (per 100

working-age population) entering the informal sector of the economy over the first decade of this century. New shadow entrepreneurs are tempted to do so to avoid potentially high regulations in the formal sector. At the initial entry stages, high startup costs and registration formalities would presumably be a more effective inducement to shadow entry than taxes, for example, which occur later after the initial entry phase. Thus, we would expect startup and registration barriers to have a more profound influence on *Shadow3* than the tax barriers. On the other hand, the other two measures of the shadow economy (*Shadow1* and *Shadow2*), capture overall prevalence of the shadow economy, which includes both established and relatively new shadow operators. Thus, these measures are likely to be potentially affected by all the barriers considered below.

The average prevalence of the shadow economy is about 30% according to both *Shadow1* and *Shadow2* (see Table 1), and the correlation between the two measures is 0.7. The sample mean for the estimated number of new business entries in the informal sector (*Shadow3)* is 1.6 per 100 adult population over the 2001-2010 period and the correlation of this measure with respect to both *Shadow2* and *Shadow3* is approximately 0.5. However, these positive correlations mask differences in the countries covered in each case. The highest (lowest) shadow prevalence under each measure was: *Shadow1* – Georgia (Switzerland); *Shadow2* – Dem. Rep. Congo (Canada); and *Shadow3* – Vanuatu (Hong Kong). See Table 1 for further details on how the shadow measures are defined along with the descriptive statistics.

3. Model and estimation

The extant literature on the incentives of firms and individuals to operate underground is grounded partly in the economics of crime, where considerations of breaking the law by going underground are subject to a cost-benefit accounting (see Becker (1968); also see Friedman et al. (2000), Gërxhani (2004) and Schneider and Enste (2000)), and partly in the desire to avoid

"excessive" government regulations and taxes (see Alm (1988), Neck et al. (2012)). Shadow operations enable unqualified entities, due either to a lack of ability (e.g., electricians without formal training) or due to a lack of government permissions and licenses (unlicensed taxis, etc.), entry into the market. Such enterprises also can avoid direct market entry costs (licensing fees) or indirect costs, such as not paying for training (see Djankov et al. (2002)).[4] The overall state of an economy might also have a significant bearing on the incentives to operate underground. For instance, the level of economic prosperity, the prevalence of democracy, and the rate of inflation are likely to be relevant (see Alm and Embaye (2013), Autio and Fu (2015), Gërxhani (2004), Schneider (2011)). Other things being the same, the underground sector would likely increase with higher inflation (as higher inflation rates increase discount rates and can also be seen as indicators of economic uncertainty), and go down with increased prosperity (due greater opportunities in the formal sector with more prosperity and strengthened monitoring of illegal activities in wealthier nations) and greater democracy (associated with greater transparency and freedom of press). These situations are exacerbated when government institutions that impose costs via mandates and rules that change slowly and when institutions are unable to respond quickly to changing technologies (e.g., the internet) and with the emergence of new markets (see Johnson et al. (1997)). However, quantifying these costs is not always easy, as they frequently have non-monetary dimensions. For instance, long regulatory delays in obtaining government clearances (e.g., environmental and health certificates) might induce some entrants to bypass queues and decide to operate in the shadow. Thus, efforts to determine empirically the influence of various factors driving the growth of the underground sector must contend with such measurement problems (see Frey and Weck-Hannemann (1984), Restrepo-Echavarria (2015), Schneider and Buehn (2013)).

[4] More broadly, the entry barriers can be seen as capturing institutional or government quality (see Knack and Keefer (1995) and La Porta et al. (1999)).

The overriding objective of this paper is to evaluate the robust influences of various causes of the shadow economy. To accomplish this goal, a broad set of candidate variables is assembled based primarily on the earlier studies on this topic. However, given the nature of the underground economy, where it can potentially have a cause and effect relation with a very large set of variables, selection of a set of potential key determinants for consideration is not easy. For the purposes of this study, our choice of determinants was based on factors identified as being significant drivers of the shadow economy in key studies from the literature (Alm and Embaye (2013), Buehn and Schneider (2012b)) and on our focus on the effects of market entry barriers. The consideration of market entry costs makes particular sense in regard to the use of entry of new shadow entrepreneurs (*Shadow3* measure).

Broadly speaking, the relation between the prevalence of the shadow economy and the factors that drive it can be organized as follows

Shadow economy = *f*(Government intervention, Macroeconomic variables, Political system), (1)

where government intervention can be seen as manifested both in the severity (costs) and complexity (number of bottlenecks), overall macroeconomic influences include the state of the economy (economic prosperity, inflation) and the size of the government (which may or may not be interventionist), and the political system includes indicators of the strength of political freedom and civil liberties within a society.

With this general background and providing more specifics on the relation in equation (1), our estimated equations in OLS are based on the following general relation (subscript *i* denotes a country):

$\text{Shadow economy}_{ij} = g(\text{Business startup}_{ik}, \text{Property registration}_{im}, \text{Tax policies}_{iy}, \text{Economic prosperity}_{i}, \text{Government size}_{i}, \text{Inflation}_{i}, \text{Democracy}_{i})$ (2)

$i = 1,2,3,\ldots$

$j = Shadow1, Shadow2, Shadow3$

$k = Start\text{-}procedures, Start\text{-}time, Start\text{-}cost$

$m = Register\text{-}procedures, Register\text{-}time, Register\text{-}cost$

$y = Tax\text{-}payments, Tax\text{-}time, Tax\text{-}total.$

The dependent variables are alternately the three measures of the shadow economy discussed above that alternately capture qualitatively somewhat different aspects of the underground sector. While reverse causality between the shadow economy and some of its determinants can potentially exist (see Schneider and Enste (2000); also, Brennan and Buchanan (1980)), our robustness methodology, focusing on modeling uncertainty and using numerous model combinations, is not equipped to deal with simultaneity issues (see Section 6 and Young and Kroeger (2015)). However, the consideration of multiple model combinations somewhat alleviates these concerns. Further, the lags with regulatory changes (e.g., changing licensing or property registration requirements) mitigate concerns about feedbacks from such variables to the shadow economy.

In addition to some widely used macroeconomic drivers of the shadow economy (see Alm and Embaye (2013), Buehn and Schneider (2012b)),[5] we consider three sets of government intervention variables dealing with the cost of doing business or business startup. These include, (i) business startup costs and procedures; (ii) property registration costs and procedures; and (iii) paying taxes. Under each set, both monetary costs and non-monetary costs (number of procedures or hurdles, time costs) are considered. Business startup and property registration cost formalities can be viewed as entry barriers for new entrepreneurs (inducing them to consider

[5] It should be pointed out that a few of the regressors in our model (specifically, *GDP*, *Tax-Total*, and *Inflation*) go into the complex calculations (involving many influences) for the measures *Shadow1* and *Shadow2*. However, besides their intuitive justification for inclusion in factors driving the shadow economy, they do not enter directly in the shadow economy calculations (for details see Alm and Embaye (2013) and Schneider (2012)).

them to shift all or part of their operations underground or to outsource to the shadow sector - see Busato et al. (2011)). These measures can be seen as capturing both the complexity (e.g., number of procedures or tax payments) and the severity (e.g., amount of taxes or regulatory costs) of government interventions.

These market entry or business operation measures have potentially different effects on the alternate shadow measures as they capture (i) different stages of market entry (startup and registration regulations are ex ante or in the initial stages, while taxes are ex post); (ii) varying frequency of regulatory transactions (startup and registration are likely one-time fixed costs, while taxes are repetitive); and (iii) different monetary dimensions (costs of various barriers deal with monetary costs, while the number of procedures and time taken address non-monetary aspects of severity of rules and regulations). Thus, these alternate considerations yield evaluation of qualitatively different drivers of the shadow economy. For instance, business startup and property registration barriers are likely to be more relevant to new entrepreneurs (*Shadow3*) considering entry, while established shadow operators (*Shadow1* and *Shadow2*) might be swayed by taxes (both procedures and magnitude) to either move underground or outsource from underground operators. In one sense, the differential incentives of new entrepreneurs, where they may heavily discount taxes down the road and place relatively greater importance on startup costs can be seen as rooted in classic cost-benefit analysis with differing present discounted values (see Brent (2009)).

Consistent with the literature on the determinants of the shadow economy, we include the level of economic prosperity, inflation rate, government size and democracy as overall economy-wide determinants of shadow activity. Among the macroeconomic influences capturing institutional details, greater economic prosperity (*GDP*) is associated with strengthened checks and balances plus with increasing the opportunity costs of operating in the shadow (as there are

greater opportunities in the formal sector in wealthier nations).[6] However, the size and nature of the shadow economy in developed and developing nations is qualitatively different (see Schneider (2011)). For instance, tax evasion is likely to be the main reason for underground activities in developed nations, while the reasons for shadow activities in developing nations might be more numerous, including bureaucratic complexity, irrational tax structures (e.g., lack of well-defined and consistent laws and procedures).

We also consider the effects of inflation and government size on the shadow economy. These factors have been identified as significant drivers of the shadow sector in some studies (Alm and Embaye (2013), Buehn and Schneider (2012b)). For instance, greater inflation increases production costs and businesses might try to reduce other costs (transactions costs – e.g., tax payments) by going underground. Inflation could also increase discount rates, prompting underground operations. A larger government size might be associated with strengthened checks and balances that deter shadow activities.[7] The effect of government size could be positive when a larger government size creates bureaucratic bottlenecks that increase propensities to operate underground, while it would be negative when a bigger government is associated with greater enforcement.

Finally, the level of democracy is included in the model as an indicator of political system related to press freedom and preservation of human rights (see Schneider (2011)). The risk of exposure and a relatively transparent legal process in democratic countries is likely to check all illegal activities, including the shadow economy. All these factors would likely mitigate underground operations due to a greater risk of exposure. The data section is next.

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[6] Economic prosperity might be correlated with some factors such as inflation and government size. To address this potential multicollinearity, we exclude GDP as a regressor in Table 3b.

[7] The degree of corruption might be intricately associated with the shadow economy in that the two illegal activities might feed off each other. However, since the two share some of the same determinants (Buehn and Schneider (2012a), Dreher and Schneider (2010)), we do not consider corruption. Plus, the empirical support for the relation between corruption and shadow economy is not clear (Buehn and Schneider (2012a)).

4. Data

The data used in this analysis to estimate the model summarized in equation (2) are drawn from a large set of countries, and with the exception of the data on new entrepreneurs, pertain to the year 2006.[8] The cost-of-doing business (CDB) measures uniformly capture the cross-country severity and complexity of government interventions and are drawn from the *Doing Business* data series produced by the World Bank. This data series addresses how business regulations affect local firms during various phases of their life cycle and covers 133 countries.[9] In the present analysis, the focus is on the complexity and cost of the regulatory process.

In our cross-national sample, the average number of annual tax payments was 34, the number of business startup procedures was 10 and the number of property registration procedures was 6. All these signify non-monetary costs related to the severity of regulations may induce some businesses to bypass these formalities by choosing to operate underground. Turning to monetary costs, the average tax rate on profits (*Tax-total*) was 53%. Again, underground operators, engaging in cash transactions "off the books", would escape the burdens of taxation, while facing possible detection and punishment related to breaking the law.

The first CDB report was in 2003 and for only a very limited number of business regulations. By 2006, that list was expanded to the 11 topics from which the data used in this analysis are drawn. Accordingly, since the most recent estimates for *Shadow1* and *Shadow2* are for 2006, CDB data are restricted to that year in the analysis presented below. Regarding the control variables in the model, data on *GDP*, *Inflation* (measured by GDP deflator) and

[8] Most recent year data are available at the time of this writing for two of the three shadow economy measures. Plus, the year 2006 falls in the middle of the span of the third (*Shadow3*) measure (see Table 1).

[9] See http://www.doingbusiness.org/~/media/GIAWB/Doing%20Business/Documents/Annual-Reports/English/DB13-Chapters/About-Doing-Business.pdf for more details. See Irwin (2014) for same caveats about these data.

Government Size are drawn from the World Development Indicators. In our sample, the average inflation rate was around 8.5% and the average government consumption expenditure was about 16% of GDP. The strength of democratic institutions in a country (democracy) data are taken from the Polity IV project. Further details and descriptive statistics on all variables used in the analysis can be found in Table 1.

5. Results of baseline models

We first present baseline OLS results before examining their robustness under two alternate model variations of equation (2). Each model includes the regulatory barriers and a measure of the strength of democratic institutions. They vary in terms of the details of which macroeconomic control variables (i.e., *GDP*, *Inflation*, *Government Size*) are included in the empirical setup. One variation excludes *GDP* but includes the other macroeconomic control variables. The logic here is that, since *GDP* is correlated with nearly every economic activity and CDB measure, it seems useful to run a set of regressions without *GDP*. The other variation assumes that *GDP* can adequately control for all macroeconomic factors that influence shadow economy size and therefore omits the inflation and government size from the regression setup.

The baseline results are reported in Table 2, along with t-statistics based on robust standard errors. Overall, the fit of various models estimated is respectable with an R^2 of at least 0.37 and statistically significant *F*-values. Further, a general, widely used test of the overall model specification, the RESET test, shows that the specification results are mixed, with *Shadow1* models performing relatively better than the other two shadow measures. However, the RESET test is not a definitive test of specification and the powers of variables considered might make a difference (see Thursby and Schmidt (1977)). In this case, our robustness technique in Section 6 below turns out to be quite useful and pertinent.

The results for the macroeconomic control variables show some interesting outcomes. First, greater economic prosperity (*GDP*) is negative and statistically significant in all cases, irrespective of the measure of the shadow economy used (Models 2.1, 2.3 and 2.5). This suggests that as nations attain greater prosperity, the relative importance of the underground sector declines, either due to strengthened checks and balances associated with economic well-being or by making the move to the underground sector relatively less attractive. This finding is not new to the extant literature (Schneider and Enste (2000)); however, we are reinforcing it with three different measures of the shadow sector.

A larger government size reduces the prevalence of the underground economy with *Shadow1* and *Shadow2* (Model 2.2 and 2.4), while greater inflation increases the shadow sector with *Shadow2* and *Shadow3* (Model 2.4 and 2.6). The effect of government size is consistent with the enforcement effect mentioned above, while the effect of inflation is consistent with the increasing discount rate arguments discussed earlier. Interestingly, the finding that the prevalence of new shadow entrepreneurs (*Shadow3*) is not affected by government size may reflect that they do not consider the full effects of the size of the government during the initial stages of their business operations. The effect of democracy is insignificant throughout.

Turning to the market regulations variables, an interesting contrast between *Shadow3* and the other two broader measures is revealed. In particular, property registration time (i.e., the time it takes to transfer property title from seller to buyer) is negative and significant with *Shadow3*, while the parameter estimates on the number of tax payments and property registration procedures variables are positive and significant with *Shadow1* and *Shadow2*. Potential shadow operators view the bureaucratic time costs associated with property registration times as entry deterring (i.e., choosing to work for someone rather than be an entrepreneur), whereas complex

tax structures induce movements into the broader shadow sector (*Shadow1* and *Shadow2*). These results hold regardless of which macroeconomic control variables are included in the model.

There is some evidence that business startup procedures increase entry of new shadow entrepreneurs (Model 2.6). Additionally, the bottlenecks from business startup times and startup costs increase the shadow sector (Model 2.4) when the shadow sector is measured via the currency demand method (*Shadow2*). All of these conclusions are statistically weak, however, when *GDP* is excluded macroeconomic control variables in the model (Model 2.5). In contrast, two factors –*Register-cost* and *Tax-time,* are statistically insignificant across all shadow measures in the OLS regressions.

Overall, we see significant variation in the influence of the various entry barriers on the shadow economy. A part of this ambiguity is driven by the qualitative differences in the measures of the shadow economy (discussed above) and in the breadth of nations covered in each case. Another factor may be attributable to multicollinearity between two or more right-hand-side variables. For example, even though the CDB variables address different dimensions to the cost of doing business, the correlation between any two measures reaches as high as 0.4 (e.g., *Start-procedures* and *Tax-time*). Further, GDP is negatively correlated with all of the CDB variables. Nevertheless, the across-the-board effectiveness of economic prosperity, and the relative (in)effectiveness of monetary versus non-monetary barriers are some noteworthy outcomes. The above results are partly driven by the choice of model specification, which in turn might be driven somewhat by the biases (conscious or otherwise) of the authors. The succeeding analysis will uniquely test the robustness of these findings using a more comprehensive, impersonal procedure.

6. Uncertainty in modeling and further robustness analysis

The preceding analysis addressed the robustness of the relationships between market regulations and shadow economy size with respect to the details of the other control variables that are included in the empirical setup (i.e., *GDP*, democratic institutions, inflation, government size). These models provide insights into what may be important determinants of the shadow economy but they are predicated on a specific set of control variables included in the regression setup (referred to as modeling uncertainty). In this section we look at the issue more comprehensively and systematically taking into account how the choice of control variables included in the model can affect the conclusions drawn. In particular, we address modeling uncertainty by examining significance of particular determinants across hundreds of model variations.

To assess how sensitive the conclusions drawn in the preceding section are to model specification, we use an estimator for model robustness offered by Young and Kroeger (2015). Their estimator builds on earlier work of Leamer (1983), Sala-i-Martin (1997), and others, by considering the influence of both sampling variability and uncertainty of model specification in the parameter estimate.[10] Assume that there are *J* possible models that could plausibly explain the phenomena under investigation and *K* possible sample data sets (or sample combinations). Young and Kroeger (2015) calculate a "robustness" statistic that incorporates both the usual sampling variance (V_s) and the "cross-specification" variance (V_m) associated with the estimation of some unknown parameter β. The latter is based on the estimates of β $\{b_1, \ldots, b_j\}$ derived from *J* possible models. The robustness statistic V_t is calculated as:

$$V_t = \frac{1}{KJ} \sum_{k=1}^{K} \sum_{j=1}^{J} \left(b_{kj} - \bar{\bar{b}}\right)^2, \qquad (3)$$

[10] Another common robustness methodology in recent years is the extreme bounds analysis (EBA). The present methodology can be seen as somewhat complementary to EBA in that, instead of bounds, the focus is on modeling the distribution of estimates across all possible combinations of plausible control variables. This can in a way be seen as focusing both on modeling uncertainty as well as sampling variability. For estimation sensitivity of findings in the case of shadow economy, see Thießen (2010) based on OECD data and a single measure of the shadow economy.

where $\bar{\bar{b}}$ is the mean estimate of β over the *K* samples and the *J* models. This statistic captures uncertainty about both the sample and the model, and the $\sqrt{V_t}$ can be thought of as an estimate of the overall standard error of the estimate.[11] The total variance, V_t, "captures all the possible sources of variation in our estimates, and includes the core reasons why different researchers can arrive at different conclusions: using a different sample, using a different model, or both" (Young and Kroeger (2015)).

The "mrobust" procedure, allows the user to specify up to *c* possible control variables that can be included in the regression set up along with the variable of interest. OLS regressions are then run on all possible combinations of the control variables - 2^c in all – and the mean parameter estimate of the variable of interest over all of these models, along with estimates of the sampling, model, and "robustness ratio" are reported. The latter is defined as the ratio of the mean parameter estimate for the variable of interest over the total standard error.[12] In addition, the percentage of these models where the parameter estimate was positive (negative) and statistically significant (95% confidence level) are also summarized. This also provides a different perspective on variable significance not typically considered using other approaches to appraising model robustness.

In undertaking this robustness analysis we again consider two alternative model setups: Model (a): (i) including *GDP* (Section 6.1 and Table 3a); and Model (b): (ii) excluding *GDP*, including government size and inflation (Section 6.2 and Table 3b). Results for each measure of the shadow economy are reported separately in these tables.

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[11] The modeling standard error "shows how much the estimate is expected to change if you take a new randomly-selected model (defined by the list of possible controls)." For further details on the estimator see Young and Kroeger (2015).

[12] The authors of the procedure caution that "[t]his is constructed as analogous to the *t*-statistic, but it is worth noting again that the underlying statistical properties of the ratio are not known, and will depend on the specified model space. We recommend the conventional critical values to guide interpretation (e.g., a robustness ratio of 2 or greater suggests robustness, by analogy to the *t*-statistic), but this is obviously a loose interpretation." (Young and Kroeger (2015, p. 15)).

6.1 Robust determinants of the shadow – Model (a): Including GDP (Table 3a)

With this variation of the model setup there are ten possible control variables to be included in the OLS regression along with the target variable of interest. In total, 1,024 models are estimated for each target variable and for each measure of the shadow economy. The results are reported in Table 3a.

Consistent with the conclusions drawn above, Table 3a shows the effect of *GDP* to be negative and significant in 100% of the 1,024 models estimated for all possible combination of control variables. This holds true for all three measures of the shadow economy analyzed. The robustness ratio is 4.4 or higher in absolute value. For the *Shadow1* and *Shadow2* measures the sampling standard error is roughly twice the size of the modeling standard error, for the *Shadow3* measure they are roughly equal.[13] The mean parameter estimates are quantitatively similar to what is reported in Table 2 for this variable and are economically sizable. For example, the mean parameter estimate for the *GDP* variable with the *Shadow1* measure (-4.41) implies that a one standard deviation increase in *GDP* decreases the size of the shadow economy by seven percent.

Examining the results for the rest of the variables of interest in this table, we follow the suggestion of Rafferty (1995), whereby if 50% of the results have the same sign and are statistically significant, the results are "weakly robust." If that percentage reaches 95%, the results indicate "strong robustness." Either outcome is displayed in bold in the tables presented in this section. Using this standard, the only other variables meeting our 50% significance threshold in this model setup are *Start-cost* and *Tax-payments*. Greater startup costs increase entry of shadow entrepreneurs (*Shadow3*) in fifty percent of the cases, while greater number of tax payments increase *Shadow1* and *Shadow2* in 100% of the models. Thus, it is not as much the

[13] To conserve space, estimates of the sampling and modeling standard error estimates are not reported. Details are available upon request.

direct costs of high taxes but the indirect costs of tax complexity related to the number of tax payments that drive businesses to operate underground. This supports the earlier conclusions drawn from Table 2. Further the potential impact of the tax complexity dimension is sizable. For example, a one standard deviation increase in this index implies that the shadow economy would increase by nearly four percent (based on the mean parameter estimate for this variable) with the *Shadow1* measure (0.17).

The estimation procedure also permits an analysis of the marginal effect of including each control variable on the parameter estimate of the variable of interest. That is, it provides insight into how important the model assumptions are in obtaining the reported parameter estimate. For example, the analysis reveals that for the tax complexity variable, the parameter estimate would be 60% higher if GDP were omitted as a control variable. Omitting any of the other control variables in this model would have much smaller impact, raising the tax complexity parameter estimate by less than 10 percent in all cases.[14]

The main take-away from this robustness check is the significance of economic prosperity, the importance of tax complexity over actual tax liability in driving the size of the shadow economy, and the differential effects of regulatory bottlenecks across new and established shadow operators. Next, we exclude economic prosperity from the set of shadow determinants and add government size and inflation.

6.2 Robust determinants of the shadow economy – Model (b): Including government size and inflation (Table 3b)

To consider the influence of other macroeconomic variables, we include government size and the rate of inflation rather than GDP in the model setup. With this set of determinants, 2,048

[14] Further details are available upon request.

model combinations are estimated for each target variable and for each measure of the shadow economy. The results are reported in Table 3b.

Like the baseline models in Table 2, inflation is positive and significant with *Shadow2* and *Shadow3*, while a larger government reduces the shadow sector in these cases. The number of tax payments has a positive and significant effect on all cases, except new shadow entrepreneurs (*Shadow3*). These findings are similar to the robustness analysis presented above (Table 3a).

Relative to the earlier analysis there is strong statistical evidence that business startup costs (*Start-cost*) have a direct influence on the size of the underground economy as measured by *Shadow2* and the prevalence of new informal entrepreneurs (*Shadow3*). Moreover, the influence of startup costs is large, a one-standard deviation increase in the value of this variable increases *Shadow2* by two percent and increases the prevalence of new informal entrepreneurs by nearly 4.2 (new business entries per 100 adult population), a figure that is *more than double* the sample mean (1.6 from Table 1) for this variable. Similar to what was found earlier, these estimates are sensitive to the inclusion of some of the other control variables in the model setup. For example, omitting either the startup procedures or inflation as control variables in the model would increase the parameter estimate on *Start-cost* by over 25% (*Shadow3*).

Finally, property registration procedures and business startup times were found to have positive influences on *Shadow1* or *Shadow2*. The evidence is strongest for startup times using the *Shadow2* measure, while for *Shadow1* measure the finding is strongest for the property registrations. In sum, the results of Table 3b generally support earlier findings, highlighting the qualitative differences across measures of the shadow economy and emphasizing the contrasting effects of tax levels versus tax complexity. These aforementioned results are noteworthy in the sense that while high tax rates are traditionally believed to be drivers of the shadow economy

(Schneider and Enste (2000)), our results show that it is rather the tax procedures or procedural complexity that induce businesses to bypass the formal sector.[15]

6.3 Summary

The overriding goal of the analysis presented above was to determine what factors contribute to the relative importance of the informal sector of a country's economy. Three alternate measures of the size of this sector were evaluated, each one distinct from the other in terms of approach taken to estimate relative sector size or significance to the local economy. Robustness analysis was conducted to determine which macroeconomic, political, and cost-of-doing business (CDB) variables consistently emerged as statistically-significant drivers of underground economy size. Viewing the results as a whole, the following conclusions can be drawn:

- Macroeconomic variables (GDP, overall government size, and inflation) emerge as important factors driving the size of the informal sector. These findings are consistent with prior literature, and should not be surprising as these factors are used indirectly in the estimation strategy to calculate two of the three shadow measures we used in this analysis (*Shadow3* is based entirely on survey data).
- Increased tax complexity, rather the level of taxation *per se*, incentivizes businesses in general to operate in the informal sector. In contrast, new entrepreneurs are most deterred by start-up costs in making the choice of whether to operate in the formal or informal sector. Here we use start-up costs as defined by the World Bank to include "all official fees and fees for legal or professional services if such services are required by law". These conclusions are novel to the literature on this topic. Importantly, none of

[15] Neck et al. (2012) posit an alternate effect of tax complexity in their theoretical model. According to them, tax complexity can have negative effects on the shadow economy when greater complexity increases legal routes for tax avoidance, resulting in a smaller supply of labor to the shadow economy. These conclusions about a possibly shrinking shadow economy are not supported by the present analysis.

these factors identified here as significant drivers of the underground economy were used in calculating any of the shadow measures considered in this analysis.

- No compelling case that any of the other CDB variables considered in this analysis were determined to be robust factors across all three shadow size measures and when controlling for macroeconomic considerations.

6.4. Employing similar sample sizes across measures of the shadow economy

To address differences in the number of nations, especially with the limited number of nations covered in the *Shadow3* measure, we reran the robustness analysis for the *Shadow1* and *Shadow2* measures with the sample comparable of countries used in informal entrepreneurship analysis. The comparable sample reduced the *Shadow1* sample by nearly two-thirds and the *Shadow2* sample by nearly a half.

The results for the macroeconomic control variables are generally comparable to what is reported above. In particular, economic prosperity continues to exhibit a robust negative relationship with shadow economy size. The evidence becomes stronger that more democratic institutions deter shadow economy activity while higher inflation promotes it in the case of the *Shadow2* measure. Government size remains a negative factor, although the evidence is less robust.

Regarding the CDB variables, the results for the start-up variables and property registration procedures are consistent in terms of the signs of parameter estimates (although somewhat less robust in terms of statistical significance). The previous conclusions regarding the tax complexity variable (number of payments) still hold, although the evidence is somewhat less robust using the *Shadow1* measure.[16] Thus, given the rather large changes in sample sizes for *Shadow1* and *Shadow2* with comparable samples, our previous results generally hold.

[16] Details are available upon request.

The concluding section follows.

8. Concluding remarks

In spite of the worldwide prevalence of the shadow or the underground economy, consensus on reliable and consistent drivers of shadow activity has eluded researchers and policymakers (see Schneider (2012)). The reasons for the lack of clarity are both theoretical and empirical. On the theoretical side, there seems to be somewhat of a disconnect between theoretical models and readily adaptable empirical functional forms. On the empirical side, besides the lack of agreement on acceptable functional forms (or modeling uncertainty), there is the more basic issue of adequate measurement of the shadow economy and appropriate model specification (Frey and Weck-Hannemann (1984), Restrepo-Echavarria (2015), Schneider and Buehn (2013)). Empirical research on the underground sector is also hampered by the inability to adequately measure the shadow sector. This research somewhat tries to address both these shortcomings somewhat by (i) considering hundreds of model variations in the determinants of the shadow economy; (ii) by employing qualitatively different measures of the shadow economy; and (iii) evaluating the effect of economic prosperity from various angles.

Specifically, this paper adds to the literature on the determinants of the shadow economy by examining the drivers of the shadow economy across alternate measures for more than 100 nations, focusing especially on the relative effectiveness of various determinants. A key contribution lies in employing a novel econometric technique to determine the statistical robustness of potential shadow determinants. The alternate shadow economy measures enable us to distinguish between new shadow entrepreneurs and the overall prevalence of the shadow economy (including both new and established underground operators). New entrepreneurs choosing between operations in the formal versus informal sectors may be driven more by entry

costs than ex-post costs such as taxes. Broadly speaking, this work can be seen as contributing both to the debate about the workings and spread of the shadow sector (Schneider (2012)) and to the issue of robustness of empirical analysis in general (Leamer (1983), Paldam (2015), Sala-i-Martin (1997)).

Our analysis, analyzing hundreds of regression combinations, reveals that greater economic prosperity was effective in reducing the shadow sector in all cases. This finding is consistent with the notion of strengthened checks and balances against illegal activities in wealthier nations and with greater opportunities in the formal sector in prosperous nations (making shadow operations relatively less attractive). Relatively speaking, greater democracy seemed more effective at checking the entry of new shadow entrepreneurs. Among entry barriers, *Startup-time*, *Tax-time* and *Tax-total* were not statistically significant in a majority of cases in any instance. In contrast, we find that procedural complexity, especially with respect to the number of tax procedures involved in paying taxes (rather than tax rates per se), are important drivers of business to the shadow, although not so much for startups. Further, business startup costs with initial procedures were especially bothersome for new entrepreneurs and in terms of magnitude, a one-standard deviation increase in startup costs increases new informal entrepreneurs by more than double the mean for this variable (Table 3b).

The policy implications are clear: simplify everything, especially tax policy. The move by many nations to digitize government services may primarily be driven by efforts to save costs. This is also espoused by the World Bank in its "Good Practices" recommendations (http://www.doingbusiness.org/data/exploretopics/paying-taxes/good-practices). However, in a number of cases, this move has also the positive side effect of reducing red tape (see Bhatnagar (2007)). Our results show that such simplification would lower prevalence of the shadow economy. Another recommendation seems to be the need for somewhat separate policies for

controlling the prevailing shadow sector versus deterring new shadow entrants. We close by espousing the virtues of extensive robustness checks of findings – a realization that is slowly dawning on economists.

References

Alm, J., "Compliance Costs and the Tax Avoidance-Tax Evasion Decision", Public Finance Quarterly, 16, 1988, 31-66.

Alm, J. and A. Embaye, "Using Dynamic Panel Methods to Estimate Shadow Economies around the World, 1984-2006", Public Finance Review 41, 2013, 510-543.

Autio, E. and K. Fu, "Economic and Political Institutions and Entry into Formal and Informal Entrepreneurship", Asia Pacific Journal of Management, 32, 2015, 67-94.

Becker, G.S., "Crime and Punishment: An Economic Approach", Journal of Political Economy, 76, 1968, 169-217.

Bhatnagar, S., "Impact Assessment Study of Computerized Services Delivery Projects from India and Chile", IT@WB Staff Working Paper no. 2, Washington, DC: World Bank, 2007. http://documents.worldbank.org/curated/en/2007/11/9337961/impact-assessment-study-computerized-services-delivery-projects-india-chile

Brennan, G. and J.M. Buchanan, The Power to Tax: Analytical Foundations of a Fiscal Constitution, Cambridge: Cambridge University Press, 1980.

Brent, R.J. (ed.), Handbook of Research on Cost-Benefit Analysis, Cheltenham, UK: Edward Elgar, 2009.

Buehn, A. and F. Schneider, "Corruption and the Shadow Economy: Like Oil and Vinegar, Like Water and Fire?" International Tax and Public Finance, 19, 2012a, 172-194.

Buehn, A. and F. Schneider, "Shadow Economies around the World: Novel Insights, Accepted Knowledge, and New Estimates", International Tax and Public Finance, 19, 2012b, 139-171.

Busato, F., B. Chiarini and E. Marchetti, "Indeterminacy, Underground Activities and Tax Evasion", Economic Modelling, 28, 2011, 831-844.

Djankov, S., R. La Porta, F. Lopez-De-Silanes and A. Shleifer, "The Regulation of Entry", Quarterly Journal of Economics, CXVII, 2002, 1-37.

Dreher, A. and F. Schneider, "Corruption and the Shadow Economy: An Empirical Analysis", Public Choice, 144, 2010, 215-238.

Frey, B. S. and H. Weck-Hannemann, "The Hidden Economy as an 'Unobserved' Variable", European Economic Review, 26, 1984, 33-53.

Friedman, E., S. Johnson, D. Kaufmann and P. Zoido-Lobatón, "Dodging the Grabbing Hand: The Determinants of Unofficial Activity in 69 Countries", Journal of Public Economics, 76, 2000, 459-493.

Gërxhani, K., "The Informal Sector in Developed and Less Developed Countries: A Literature Survey", Public Choice, 120, 2004, 267-300.

Irwin, D., "Doing Business: Using Ratings to Drive Reform", Journal of International Development, 26, 2014, 658-667.

Johnson, S., D. Kaufmann and A. Shleifer, "The Unofficial Economy in Transition", Brookings Papers on Economic Activity, 2, 1997, 159-239.

Knack, S. and P. Keefer, "Institutions and Economic Performance: Cross-Country Tests Using Alternative Institutional Measures", Economics and Politics, 7, 1995, 207-227.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer and R. Vishny, "The Quality of Government", Journal of Law, Economics, and Organization, 15, 1999, 222-279.

Leamer, E.E., "Let's Take the Con out of Econometrics", American Economic Review, 73, 1983, 31-43.

Neck, R., J.U. Wächter and F. Schneider, "Tax Avoidance versus Tax Evasion: On Some Determinants of the Shadow Economy", International Tax and Public Finance, 19, 2012, 104-117.

Paldam, M., "Simulating an Empirical Paper by the Rational Economist", Empirical Economics, May 2015, in press.

Rafferty, A., "Bayesian Model Selection in Social Research", Sociological Methodology, 25, 1995, 111-163.

Restrepo-Echavarria, P., "Measuring Underground Economy Can be Done, But it is Difficult", The Regional Economist, January 2015, 10-11. www.stlouisfed.org

Sala-i-Martin, X., "I Just Ran Two Million Regressions", American Economic Review, 87, 1997, 178-183.

Schneider, F., "The Shadow Economy and Work in the Shadow: What Do We (Not) Know?" IZA Discussion Paper No. 6423, March 2012.

Schneider, F. (ed.), Handbook on the Shadow Economy, Cheltenham, UK: Edward Elgar, 2011.

Schneider, F. and A. Buehn, "Estimating the Size of the Shadow Economy: Methods, Problems and Open Questions", CESifo working paper #4448, 2013.

Schneider, F., A. Buehn and C.E. Montenegro, "New Estimates for Shadow Economies all over the World", International Economic Journal, 24, 2010, 443-461.

Schneider, F. and D.H. Enste, "Shadow Economies: Size, Causes, and Consequences", Journal of Economic Literature, 38, 2000, 77-114.

Tanzi, V. (ed.), The Underground Economy in the United States and Abroad, Lexington: Lexington Books, 1982.

Thießen, U., "The Shadow Economy in International Comparison: Options for Economic Policy Derived from an OECD Panel Analysis", DIW Berlin Discussion Paper #1031, July 2010.

Table 1
Variable definitions, summary statistics and data sources

Thursby, J.G. and P. Schmidt, "Some Properties of Tests for Specification Error in a Linear Regression Model", Journal of the American Statistical Association, 72, 1977, 635-641.

Torgler, B. and F. Schneider, "Shadow Economy, Tax Morale, Governance and Institutional Quality: A Panel Analysis", IZA Discussion Paper # 2563, 2007.

World Bank, "About *Doing Business*: Measuring for Impact", 2013. Available at http://www.doingbusiness.org/~/media/GIAWB/Doing%20Business/Documents/Annual-Reports/English/DB13-Chapters/About-Doing-Business.pdf.

Young, C. and K. Kroeger, "Model Uncertainty and Robustness: A Computational Framework for Multi-Model Analysis," mimeo, Stanford University, February 2015.

Table 1
Variable definitions, summary statistics and data sources

Variable	Description	Mean* (Std. Dev.)	Source
Shadow Economy Measures			
Shadow1	Shadow economic size as % of official GDP. Estimation based on MIMIC method and calibrated using currency demand approach.	32.25 (12.3)	[1]
Shadow2	Shadow economic size as % of official GDP. Estimation based on currency demand approach.	31.01 (9.4)	[2]
Shadow3	Informal entrepreneurship prevalence, number of new business entries per 100 adult population, 2001-2010.	1.60 (2.0)	[3]
Cost of Doing Business Variables			
Start-procedures	Starting a business – number of procedures.	9.52 (3.4)	[4]
Start-time	Starting a business – time (days).	49.54 (62.9)	[4]
Start-cost	Starting a business – cost (% of income per capita).	89.28 (209.6)	[4]
Register-procedures	Registering property – number of procedures.	6.21 (2.4)	[4]
Register-time	Registering property – time (days).	89.67 (120.1)	[4]
Register-cost	Registering property – cost (% of property value).	7.05 (5.6)	[4]
Tax-payments	Paying taxes – number of payments per year.	33.98 (21.4)	[4]
Tax-time	Paying taxes – total time (hours per year).	330.35 (303.2)	[4]
Tax-total	Paying taxes – total tax rate (% of profit).	53.38 (43.1)	[4]
Control Variables			
GDP	Log of GDP per capita (constant 2005 US$).	8.09 (1.6)	[5]
Democracy	Democracy index, ranges from 0 (least) to 10 (most).	5.69 (3.9)	[6]
Inflation	Inflation, GDP deflator (annual %)	8.46 (10.46)	[5]
Government Size	General government final consumption expenditure (% of GDP)	15.55 (7.74)	[5]

Notes: All data are for 2006 unless otherwise indicated.
** Descriptive statistics are based on maximum available observations.*
Sources:

1. *Schneider (2012), Table 1A.*
2. *Alm and Embaye (2013), Appendix.*
3. *Autio and Fu (2015), Table 1.*
4. *Doing Business, The World Bank. Available at http://doingbusiness.org/.*
5. *World Development Indicators, The World Bank. Available at http://data.worldbank.org/data-catalog/world-development-indicators.*
6. *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2013. Available at http://www.systemicpeace.org/polity/polity4.htm.*

Table 2

Determinants of the shadow economy: Baseline models

Dependent variable →	***Shadow1***		***Shadow2***		***Shadow3***	
	2.1	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**
GDP	-4.14** (6.7)		-2.45** (4.0)		-1.21** (2.7)	
Democracy	0.11 (0.4)	-0.29 (1.1)	0.05 (0.2)	-0.21 (1.0)	0.09 (0.8)	-0.09 (1.1)
Inflation		0.05 (1.1)		0.09** (2.6)		0.07** (2.8)
Government Size		-0.35** (2.3)		-0.34** (2.3)		0.01 (0.72)
Start-procedures	-0.03 (0.1)	0.15 (0.4)	0.10 (0.4)	0.22 (0.8)	0.04 (0.6)	0.14* (1.9)
Start-time	0.01 (1.1)	0.04 (1.0)	0.03 (1.0)	0.06** (2.5)	-0.01 (0.9)	0.00 (0.2)
Start-cost	0.00 (1.2)	-0.00 (0.1)	0.01 (1.1)	0.02** (3.6)	0.01 (0.8)	0.02** (2.3)
Register-procedures	0.40 (1.1)	0.84** (2.2)	0.32 (0.9)	0.49* (1.6)	-0.01 (0.2)	0.00 (0.0)
Register-time	0.00 (0.7)	0.01 (1.6)	-0.00 (0.1)	0.00 (0.3)	-0.00* (1.8)	-0.00** (2.2)
Register-cost	-0.06 (0.3)	0.19 (1.0)	0.07 (0.6)	0.12 (1.0)	-0.03 (0.5)	-0.04 (0.7)
Tax-payments	0.11** (3.0)	0.17** (3.6)	0.09** (2.5)	0.11** (3.5)	-0.03 (1.6)	0.00 (0.2)
Tax-time	0.00 (0.9)	0.00 (0.1)	0.00 (0.2)	-0.00 (0.4)	-0.00 (0.4)	-0.00 (0.3)
Tax-total	-0.01 (0.8)	0.03* (1.7)	-0.01 (0.4)	-0.03* (1.8)	-0.01 (0.6)	-0.01 (0.9)
N	141	136	100	97	62	61
R^2	0.49	0.37	0.56	0.57	0.60	0.62
F-value	24.4**	10.1**	12.0**	18.4**	6.7**	8.3**
RESET test (F-value)	1.3	3.6**	9.8**	2.2*	10.2**	12.0**

*Notes: See Table 1 for variable details. Constants included but not reported. All models are estimated using OLS. Robust t-statistics are in parentheses (absolute values). * denotes statistical significance at 10%, and ** denotes statistical significance at 5% (or better).*

Table 3a
Robustness of determinants of the shadow economy, with GDP
***Shadow =f*(Variable of Interest, Other Variables)**

Shadow Economy Measure	***Mean (β)***	***Robustness Ratio***	***Positive & Significant(%)***	***Negative & Significant(%)***	***Mean R^2 (observations)***	***Models***
Variable of Interest: GDP						
Shadow1	**-4.41**	**-6.44**	**0**	**100**	**0.46 (141)**	**1024**
Shadow2	**-3.00**	**-4.60**	**0**	**100**	**0.52 (100)**	**1024**
Shadow3	**-1.06**	**-4.43**	**0**	**100**	**0.57 (62)**	**1024**
Variable of Interest: Democracy						
Shadow1	-0.21	-0.50	0	27	0.35 (141)	1024
Shadow2	-0.21	-0.56	0	31	0.45 (100)	1024
Shadow3	-0.05	-0.39	0	45	0.45 (62)	1024
Variable of Interest: Start-procedures						
Shadow1	0.42	0.96	24	0	0.36 (141)	1024
Shadow2	0.49	1.33	41	0	0.46 (100)	1024
Shadow3	0.09	0.93	29	0	0.45 (62)	1024
Variable of Interest: Start-time						
Shadow1	0.01	0.87	1	0	0.35 (141)	1024
Shadow2	0.04	1.53	41	0	0.45 (100)	1024
Shadow3	0.00	0.00	1	0	0.43 (62)	1024
Variable of Interest: Start-cost						
Shadow1	0.003	0.69	3	0	0.35 (141)	1024
Shadow2	0.01	1.29	48	0	0.46 (100)	1024
Shadow3	**0.02**	**1.34**	**50**	**0**	**0.47 (62)**	**1024**
Variable of Interest: Register-procedures						
Shadow1	0.71	1.50	41	0	0.36 (141)	1024
Shadow2	0.49	1.39	22	0	0.45 (100)	1024
Shadow3	0.02	0.16	0	0	0.43 (62)	1024
Variable of Interest: Register-time						
Shadow1	0.008	1.00	1	0	0.35 (141)	1024
Shadow2	0.002	0.36	0	0	0.44 (100)	1024
Shadow3	-0.002	-1.02	0	0	0.44 (62)	1024
Variable of Interest: Register-cost						
Shadow1	0.12	0.50	11	0	0.35 (141)	1024
Shadow2	0.17	1.00	19	0	0.45 (100)	1024
Shadow3	-0.03	-0.42	0	0	0.43 (62)	1024
Variable of Interest: Tax-payments						
Shadow1	**0.17**	**2.48**	**100**	**0**	**0.39 (141)**	**1024**
Shadow2	**0.12**	**2.48**	**100**	**0**	**0.48 (100)**	**1024**
Shadow3	-0.004	-0.19	4	31	0.44 (62)	1024
Variable of Interest: Tax-time						
Shadow1	0.004	1.04	13	0	0.35 (141)	1024
Shadow2	0.002	0.57	6	0	0.44 (100)	1024

Table 3a
Robustness of determinants of the shadow economy, with GDP
***Shadow =f*(Variable of Interest, Other Variables)**

Shadow Economy Measure	***Mean (β)***	***Robustness Ratio***	***Positive & Significant(%)***	***Negative & Significant(%)***	***Mean R^2 (observations)***	***Models***
Shadow3	-0.000	-0.05	0	0	0.43 (62)	1024
Variable of Interest: Tax-total						
Shadow1	0.01	0.40	3	0	0.35 (141)	1024
Shadow2	0.002	0.05	5	2	0.45 (100)	1024
Shadow3	-0.01	-1.01	0	3	0.44 (62)	1024

Notes: Robustness ratio is the ratio of the mean parameter estimate for the variable of interest over the total standard error.

Table 3b
Robustness of determinants of the shadow economy, with Government Size, Inflation; no GDP
***Shadow =f*(Variable of Interest, Other Variables)**

Shadow Economy Measure	***Mean (β)***	***Robustness Ratio***	***Positive & Significant(%)***	***Negative & Significant(%)***	***Mean R^2 (observations)***	***Models***
Variable of Interest: Democracy						
Shadow1	-0.43	-1.52	0	17	0.27 (136)	2,048
Shadow2	-0.36	-1.41	0	27	0.44 (97)	2,048
Shadow3	-0.12	-1.85	0	49	0.46 (61)	2,048
Variable of Interest: Inflation						
Shadow1	0.08	0.92	0	0	0.27 (136)	2,048
Shadow2	**0.12**	**1.95**	**59**	**0**	**0.45 (97)**	**2,048**
Shadow3	**0.07**	**4.19**	**100**	**0**	**0.53 (61)**	**2,048**
Variable of Interest: Government Size						
Shadow1	**-0.44**	**-2.23**	**0**	**85**	**0.28 (136)**	**2,048**
Shadow2	**-0.53**	**-2.68**	**0**	**100**	**0.46 (97)**	**2,048**
Shadow3	-0.06	-1.04	0	17	0.45 (61)	2,048
Variable of Interest: Start-procedures						
Shadow1	0.59	1.36	36	0	0.28 (136)	2,048
Shadow2	**0.65**	**1.79**	**67**	**0**	**0.45 (97)**	**2,028**
Shadow3	**0.17**	**2.50**	**96**	**0**	**0.48 (61)**	**512**
Variable of Interest: Start-time						
Shadow1	0.05	1.44	23	0	0.27 (136)	2,048
Shadow2	**0.07**	**2.29**	**83**	**0**	**0.46 (97)**	**2,048**
Shadow3	0.00	0.29	5	0	0.44 (61)	2,048
Variable of Interest: Start-cost						
Shadow1	0.00	0.57	2	0	0.27 (136)	2,048
Shadow2	**0.01**	**2.24**	**96**	**0**	**0.46 (97)**	**2,048**
Shadow3	**0.02**	**2.85**	**100**	**0**	**0.50(61)**	**2,048**
Variable of Interest: Register-procedures						
Shadow1	**0.97**	**2.21**	**87**	**0**	**0.28 (136)**	**2,048**
Shadow2	0.61	1.80	45	0	0.44 (97)	2,048
Shadow3	0.04	0.47	1	0	0.44 (61)	2,048
Variable of Interest: Register-time						
Shadow1	0.01	1.41	7	0	0.27 (136)	2,048
Shadow2	0.00	0.43	0	0	0.43 (97)	2,048
Shadow3	-0.00	-0.96	0	0	0.44 (61)	2,048
Variable of Interest: Register-cost						
Shadow1	0.27	1.52	12	0	0.27 (136)	2,048
Shadow2	0.23	1.50	31	0	0.44 (97)	2,048
Shadow3	-0.04	-0.56	0	0	0.44 (61)	2,048
Variable of Interest: Tax-payments						
Shadow1	**0.20**	**4.16**	**100**	**0**	**0.32 (136)**	**2,048**

Table 3b
Robustness of determinants of the shadow economy, with Government Size, Inflation; no GDP
***Shadow =f*(Variable of Interest, Other Variables)**

Shadow Economy Measure	***Mean (β)***	***Robustness Ratio***	***Positive & Significant(%)***	***Negative & Significant(%)***	***Mean R^2 (observations)***	***Models***
Shadow2	**0.13**	**3.16**	**100**	**0**	**0.47 (97)**	**2,048**
Shadow3	0.00	0.39	1	0	0.44 (61)	2,048
Variable of Interest: Tax-time						
Shadow1	0.00	0.82	10	0	0.27 (136)	2,048
Shadow2	0.00	0.34	8	0	0.43 (97)	2,048
Shadow3	0.00	0.14	0	0	0.44 (61)	2,048
Variable of Interest: Tax-total						
Shadow1	0.03	1.40	9	0	0.27 (136)	2,048
Shadow2	-0.00	-0.07	8	5	0.44 (97)	2,048
Shadow3	-0.01	-0.57	0	0	0.44 (61)	2,048

Notes: Robustness ratio is the ratio of the mean parameter estimate for the variable of interest over the total standard error.