Drivers of the underground economy for over a century:
A long term look for the United States

Rajeev K. Goel *
Illinois State University
Kiel Institute for the World
Economy

James W. Saunoris **
Eastern Michigan University

Friedrich Schneider ***
Johannes Kepler University

Revised May 2018

Abstract

Using data over 1870-2014, this paper provides long-term analysis of the determinants of U.S. shadow economy. Results show that greater trade openness and a bigger government reduced shadow activity, with inflation and prosperity being statistically insignificant. Politically, congressional party homogeneity reduced the shadow economy. Further, the U.S. shadow economy increased during World War II while the effects of World War I were insignificant and the great depression reduced shadow activity. Finally, geographic changes resulting from the addition of new states to the union was a positive. The short-run relationship(s) between the shadow economy and its determinants exhibits some differences.

_____

* Department of Economics, Illinois State University, Normal, Il 61790-4200, USA. Email: rkgoel@ilstu.edu. The authors' names appear in alphabetical order and no seniority of authorship is implied. An earlier version of this paper was circulated as an IZA Discussion Paper (#10857). We thank a referee for insightful comments and suggestions.

** Corresponding author. Address: Department of Economics, Eastern Michigan University, Ypsilanti, MI 48197, USA. Email: jsaunori@emich.edu.

*** Department of Economics, Johannes Kepler University Linz, Altenbergerstr. 69, A-4040 Linz, Austria. Email: friedrich.schneider@jku.at.

1. Introduction

The shadow or the underground sector has persisted across developed and developing nations for a long time. Yet formal empirical investigations of its causes and effects are relatively recent and mostly limited to the years after the middle of the twentieth century (see Buehn and Schneider (2012), Gërxhani (2004), Schneider (2011), Schneider and Enste (2000), Schneider et al. (2010), Tanzi (1982)). A major issue limiting formal investigations of the shadow economy pertains to the measurement of the extent of the underground sector. Informal sector activities encompass many forms including unlicensed service sector providers, work for kind, undocumented cash transactions, illegal gambling and smuggling, etc. that are nearly impossible to effectively track (see Frey and Weck-Hannemann (1984), Kirchgässner (2017), Restrepo-Echavarria (2015), Schneider and Buehn (2013)). Yet economists have been able to provide some reliable estimates of the shadow sector across nations using different measurement techniques (see Alm and Embaye (2013), Schneider et al. (2010)) that mainly span less than a century. Recently, however, Géidigh et al. (2016) provide estimates on the prevalence of the shadow economy for 3-4 nations over more than a century.

This paper examines the determinants of the U.S. shadow economy over nearly a century and a half (from 1870-2014), paying attention to economic, political, and geographic factors. This long term analysis enables us to consider the effects of some unprecedented and significant shocks such as the two world wars and the great depression as well as the inclusion of thirteen states that entered into the union after 1870. Beyond that, the United States presents an interesting and informative case study. It is a developed country, that is pretty much insulated from bordering nations (except for neighbors Canada and Mexico) and yet the shadow sector has persisted in double-digits over some time (see Table 1). Further, the substantial autonomy that the federalist structure of the U.S. government grants individual states in terms of setting regulations and taxes provides differing incentives to individuals and firms to operate in the underground sector. In recent years, a number of studies have been conducted focusing on the U.S. shadow economy (see Berdiev et al. (2015), Goel and Saunoris (2016a), Tanzi (1982)). However, these studies are limited to a few decades and do not provide a long-term view.[1] Equally important, none of the studies examine the set of political factors and external shocks that are considered here. Hence, we argue that the United States is a proper example to study long term effects on the shadow economy.

Figure 1 illustrates the size of the U.S. shadow economy over time with the four shaded areas denoting the four major events that occurred during this time period: World War I (1914-1918), The Great Depression (1929-1939), World War II (1939-1945), and the Great Recession (2007-2009). The average size of the U.S. shadow economy over this time period is 15.3% of GDP, with a peak in 1914 of 36.9% and reaching a minimum in 2009-2010 of 5.4%. The shadow economy increased significantly shortly after the turn of the century before declining following the end of World War I. Interestingly, the significant rise in the shadow economy followed the passage of the Gold Standard Act in 1900, which ended bimetallism and established the gold standard for redeeming paper currency. Moreover, the increase in the shadow economy during

---

[1] See Tanzi (1983) for an example of study covering a relatively longer period.

the period 1885-1895 was when five new states entered into the union (North Dakota, South Dakota, Montana (1889) and Idaho (1890)). Despite prohibition, the shadow economy experienced a steady decline during the affluent 1920's, only to be reversed by the onset of the Great Depression and further expanded during World War II. Not surprisingly, the growth in the shadow economy during this time was a result of the slack in the official economy for consumer goods and services that were then absorbed by the development of black markets. The size of the shadow economy continued to shrink post-World War II due to a robust private sector and the shrinking of the public sector; however, the shadow economy saw a resurgence during the 1950's to the mid-1970's during a period when the U.S. saw an expansion of the government as part of President Johnson's Great Society Program and the high inflation in the early 1970's. After that, the drastic tax cuts and deregulation during the Reagan Administration as well as the overall health in the official economy contributed to the steady decline in the shadow economy.

Figure 1: Prevalence of the U.S. Shadow Economy (% of GDP) from 1870-2014
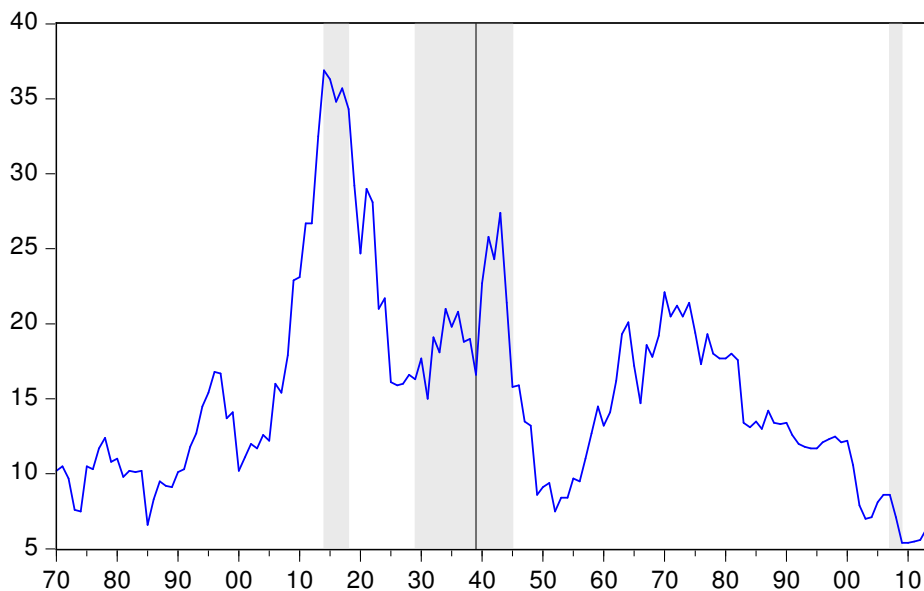
As one realizes, there are numerous forces that have a bearing on the shadow economy both in terms of its existence and evolution over time. World War I was an unprecedented event, catching the public and governments somewhat off guard. The huge spike in shadow activity could be due to greater subcontracting to the underground sector in rapid war preparations, and the drop in shadow economy following WWII might be due to fewer subcontracting opportunities plus better monitoring due to learning from the past (i.e., WWI). The drop during prohibition may be due to heightened awareness of authorities towards smuggling and other underground activities (or underground operators focusing their efforts on making moonshine at the cost of other shadow activities). Another key development over time that is hard to capture is technological change. The pace of technological change varies over time and across sectors. New technologies open opportunities for both legal and shadow operators, while at the same time often

empowering and debilitating enforcement agencies. The swings in shadow economy over time might be due to the nature and pace of technologies changing (keeping in mind that any measure of the shadow economy is less than perfect).

Although we provide some plausible explanations for the development of the shadow economy using the Géidigh et al. (2016) measure over the period 1870 to 2014, there remain open questions—e.g. following the sharp increase in the shadow economy at the start of prohibition, what caused the gradual fall in its size subsequently? Of course, it would be ideal to be able to compare this measure of the shadow economy to other widely used measures, however, there are no other figures from other sources that cover such a large time span. Nevertheless the reader should keep in mind, that in this paper our main research interest is not an explanation of the development of this shadow economy series but to verify certain hypotheses (see Section 2.1). With that said, in order to check whether the reliability of our results does not depend on the specific shadow economy series, we made an attempt to partially use an alternative measure of the U.S. shadow economy. The only one we are aware of is the construction of the U.S. shadow economy series by Tanzi (1983) using the currency demand approach over 1930 to 1980, which we extended to 2015. To construct a comparable measure of the shadow economy using the currency demand approach over a similar time period as our main measure we appended the Géidigh et al. (2016) measure of the shadow economy from 1870 to 1935 to the Tanzi (1983) measure from 1936 to 2015. To mitigate the bias in the Tanzi (1983) measure as a result of the assumption that the initial value of the shadow economy is zero we started the Tanzi (1983) measure in 1935. The correlation between the two measures of the shadow economy is a modest 0.58, suggesting they are capturing somewhat different aspects of the shadow economy.[2] Although this alternate measure of the shadow economy is far from ideal, it provides a useful robustness check. Using the methodology explained in Section 3 we re-ran the model using this alternate measure of the shadow economy and report the results in the Appendix. The reader will notice that they are quite similar, which strengthens our argument to use the Géidigh et al. (2016) shadow economy series.[3]

The purpose of this paper is to better understand the determinants of the shadow economy over a long time period. New developments in time series analysis enable us to examine the short-run and long-run effects of important economic, political, and geographic influences of the shadow economy. The longer term view also enables a better accounting of possible hysteresis in the prevalence of the informal sector. The possibility of hysteresis has been noted elsewhere in the literature (see Eilat and Zinnes (2002)). An understanding of the drivers of the underground economy over a long span contributes both to the literature and policy formulation.

In the long run, results show that trade openness and the size of government decreased the prevalence of the shadow economy, while inflation and economic prosperity had no significant

---

[2] Although recent developments in payment technologies have resulted in a decline in the use of cash in the formal sector, we argue that these technologies had limited effect on the use of cash underground, given the lack of readily available substitutes. However, recent innovations such as cryptocurrency might rival cash as adoption of this currency becomes more widespread. Formal research on the influence of cryptocurrencies would emerge as corresponding data become available.

[3] The diagnostic tests for these results suggest to use caution when interpreting the coefficients.

influence. Politically, presidential vetoes was statistically insignificance, whereas congressional party homogeneity significantly decreased the shadow economy. The amalgamation of new states added to the union increased the shadow economy. Lastly, U.S. shadow economy increased over World War II, with no effect from World War I, but experienced a decline during the great depression. Remarkably, the short-run determinants influenced the shadow economy somewhat differently.

The rest of the paper is organized as follows. The next section 2 outlines our empirical strategy to formally examine the determinants of the US shadow economy over the period 1870 to 2014. In section 3, the data and the estimation procedure are shown. Section 4 presents the empirical results and the final section draws some conclusions.

2. Empirical setup

2.1 The main causes determining the shadow economy

The determinants of the shadow economy are based on the extant literature (see, e.g., Berdiev and Saunoris (2016), Gërxhani (2004), Goel and Nelson (2016), and Schneider and Enste (2000)). In general, the incentives of firms and individuals to operate underground or in the informal sector stem from the desire to evade government regulations (see Djankov et al. (2002)) and/or avoid paying taxes (see Busato et al. (2011), Neck et al. (2012)). The level of government's desire to check these incentives via enforcement serve as counterbalances. In rare cases, unexpected external shocks (e.g., wars, natural disasters) bear upon both these motives. Our long time series for the United States enables us to uniquely take account of some of these influences. Specifically, the tax burden is proxied by the size of government as well as inflation (i.e. the "inflation tax"). Government size also accounts for the degree of public sector services. Trade openness and vetoes and party homogeneity account for economic freedom and political freedom, respectively, which relate to the quality of institutions (Cebula et al. (2015); Hall and Lawson (2014)). Furthermore, post-1870 the U.S. continued to experience significant changes in its landscape with the addition of several states that could aid shadow activities by providing additional opportunities and spillovers (see, e.g., Goel and Saunoris (2014)).

The general form of the estimated relation for causes of the U.S. shadow economy over the period 1870 to 2014, with shadow economy (*Shadow*) as the dependent variable, may be written as (see Table 1 for variable details)

Shadow economy = f (economic factors$_m$, political factors$_k$, geographic factors$_p$, shocks$_j$,)

$$\tag{1}$$

where

$m = GDP, INFL, OPEN, GOVSIZE$

$k = VETOES, PARTY$

$p = NEWSTATES$

j = WWI, WWII, Depression

Among economic factors, we include the inflation rate (*INFL*), government expenditures as percent of GDP (*GOVSIZE*), trade openness (measured as imports plus exports as a percent of GDP), (*OPEN*), and the log of per capita GDP (*GDP*). These factors have rather consistently been identified in the literature to affect the spread of the shadow economy (see Goel and Nelson (2016)).

Among the main influences driving individuals and firms underground include government regulations and taxes (see Friedman et al. (2000)). While obtaining data on tax rates and regulations over the long span of this study was problematic with all the changes in bureaucracies that affect regulations and the tax codes (and deductions), we attempt to broadly capture these by including a measure for the overall size of government (*GOVSIZE*).[4]

On the one hand, greater government spending presents opportunities for outsourcing to the underground sector (e.g., unlicensed subcontractors in highway construction), plus greater red tape associated with a bigger government induces some firms to operate underground. On the other hand, a larger government size might arise due to greater spending on enforcement. In that case the underground sector would decline. Moreover, these effects might differ over time as institutions evolve and individuals have greater freedom to alter behavior over time. The long time series in this study enables us to capture these influences. Hence, we cannot formulate a clear-cut hypothesis H1 about the effect of the size of government on the shadow economy.

The rate of inflation (*INFL*) can be seen as accounting for inflation tax. With regard to the shadow economy, inflation increases individuals discount rates that might induce them to increase short term returns by not paying taxes and operate underground (see Goel and Nelson (2016)). Our hypothesis H2 is:

> H2: *The higher the inflation rate, the higher is the shadow economy, ceteris paribus.*

Another important determinant of shadow economy development is the strength of the official sector including the quality of official institutions (see Dreher et al. (2009)). To capture these important aspects, we include *GDP*. The pro-cyclicality of the shadow economy is a result of the income effect that increase demand for small scale goods and services that are easily provided by the shadow economy while also increasing subcontracting opportunities in the underground sector, whereas the counter-cyclicality results from the substitution effect as depressed incomes

---

[4] In place of government size we also considered using the top marginal tax rate (from the Tax Policy Center (http://www.taxpolicycenter.org/statistics/historical-highest-marginal-income-tax-rates)) for the period 1870-2014 (prior to 1913 we use zero for the top marginal tax rate).
Overall, the results remained fairly robust with some minor exceptions. In particular, in the long run *GDP* was negative and significant, while *OPEN* remains negative and significant. The coefficient on tax rates was negative and insignificant. Furthermore, *PARTY* continued to be negative (and statistically significant), and *NEWSTATES* remained positive and statistically significant.
The short-run results showed similar findings as the baseline results. That is, inflation positively affected the shadow economy, and more trade openness and higher tax rates had a positive impact. Thus, in the short run, higher taxes prompted the expected move to the underground economy. Lastly, *PARTY* shows mixed results and *NEWSTATES* was statistically insignificant. Lastly, the great depression continues to show a negative effect on the shadow economy, whereas both world wars had insignificant effects. These results are available upon request.

incentivize individuals to seek out cheaper alternatives in the shadow economy to save money. However, over the longer term institutions improve with the level of economic development thus raising the opportunity costs of producing underground (see Goel and Nelson (2016)). Thus, the overall influence of economic prosperity would depend upon which effect dominates.

Hence, hypothesis H3 reads:

H3: *The effect of GDP on the shadow economy would be positive if the subcontracting effect is dominant and negative if the institutional improvement effect dominates, ceteris paribus.*

Finally, we include a measure for the amount of trade openness (*OPEN*) in the U.S. Foreign producers act as competitors to both domestic formal and informal sectors. These effects too can vary over time. For example, trade openness increases competition in the short run, but over time trade can influence economic and political institutions (see, for example, Do and Levchenko (2009)). Consequently, we cannot formulate a clear-cut hypothesis H4 about the effect of trade-openness on the shadow economy.

The shadow economy has numerous causes and effects and the role of the government is important. Government has a bearing on institutions that would limit the shadow sector on the one hand (via better governance and policing) and on the other hand, a larger government can add opportunities for subcontracting in the shadow economy. While government size has been used as a determinant of the shadow economy (see Goel and Nelson (2016)), given its vast scope, this variable masks many individual channels that might have important, often different, influences. Thus, to account for the quality of government, we include two political variables that are relevant, especially in the case of the U.S. and unique to the literature.

Specifically, we uniquely consider two influences: (i) *VETOES*: the number of congressional bills vetoed by the sitting President each year; and (ii) *PARTY*: a dummy variable identifying the years in which the U.S. House and the Senate were held by the same political party. Both these variables capture the strength of the government and signal resolve in (potentially) tackling illegal activity including the informal sector.[5] For instance, when both Houses of Congress are held by the same party, legislations, including legislations to combat the underground sector, would be more easily enacted. This is facilitated by a coherent agenda of the same party controlling the Congress. Conversely, political polarization could result in legislative gridlock and potentially send mixed signals about the government's resolve in fighting illegal activities, including the shadow economy. On the other hand, greater exercise of the veto power represents an activist presidency, showing exercised and latent power of the sitting president. This is likely to have a deterrent effect on crime. Of course, these two variables would be potentially related if both Houses of Congress were of the same party in majority. Then chances for presidential vetoes are limited, however, the correlation between these two variables is small (0.09)--.Table 1A shows details about the historical composition of the U.S. Congress. Besides adding a new dimension, the consideration of political variables enables us to account for changing efficacy of the government over the long period under consideration in this study. Again, here we cannot

---

[5] These variables can be seen as proxying for enforcement variables such as police or judicial employment.

formulate a clear-cut hypothesis H5 about the influence of these variables on the shadow economy.

Over the course of the long period under study, the composition of the United States changed as new states joined the union. Specifically, over this period, thirteen states were added to the union. These included Colorado (1876), North Dakota (1889), South Dakota (1889), Montana (1889), Idaho (1890), Wyoming (1890), Utah (1896), Oklahoma (1907), New Mexico (1912), Arizona (1912), Alaska (1959), and Hawaii (1959). This expansion likely affected the prevalence of the shadow economy by opening new subcontracting opportunities in the shadow sector, disturbing old alliances, and posing new challenges for law enforcement. Further, there was heightened government spending in initial years in the new states to build infrastructure and government machinery, which affected the shadow economy. The addition of new states adds to spillovers over shadow activity over state borders (e.g. smuggling). Of course more states in the union means more resources for enforcement of shadow (and perhaps a different aspect of government decentralization that has been shown to affect shadow activity (Goel and Saunoris (2016b)). Further, more states promote opportunities for "laboratory federalism" in which states (as well as federal government) learn from one another on more efficient ways to combat shadow activities or provide more efficient level of public goods. To account for the historical evolution and amalgamation of U.S. states over this long time period, we include in our analysis a variable (*NEWSTATES*) that captures these thirteen states that entered the union after 1870.[6] The influence of these new states to the union can be either positive or negative depending on which effect dominates. Therefore, hypothesis H6 is ambiguous.

Finally, the long period under study enables us to take account of the significant and unprecedented disturbances due to the two world wars and the great depression. These shocks likely diverted government attention to other matters, leaving less attention to controlling the underground sector. Plus, immediate demands of rapid and specialized production during war years might have necessitated outsourcing to the informal sector to meet deadlines.[7] Unforeseen events present new opportunities and the underground sector has lower entry barriers for firms and individuals to avail of these opportunities. On the other hand, the Great Depression can be seen as a shock to GDP with resulting effect on institutions and less resources for formal sector production (and consequently, less outsourcing to the informal sector). Here we can again formulate a clear-cut hypothesis H7:

H7: *The more intense exogenous shocks like wars, the higher is the shadow economy, ceteris paribus.*

The data and estimation used to formally analyze equation (1) are discussed in the following section.

---

[6] While the *NEWSTATES* variable is unique in the extant literature, it is admittedly somewhat simplistic capturing territorial expansion with the inclusion of new states. This expansion, while having important implications for growth of the shadow sector, does not capture relevant qualitative geopolitical and socio-economic differences in the composition of the new states.

[7] The war years also limited foreign competition.

3. Data and estimation

We first discuss the data employed before turning to the estimation strategy.

3.1 Data

The data set includes annual time-series data for the U.S. over the period 1870 to 2014. Measuring the size of the shadow economy is difficult because shadow participants wish to remain anonymous for obvious reasons. These obstacles inhibit understanding of the determinants of the shadow economy, especially over long time periods. Recently, however, Géidigh et al. (2016) use the currency method to estimate the U.S. shadow economy as a percent of GDP annually from 1870 to 2014.[8] The main assumption of the currency demand method is that cash is used to fuel underground enterprises and is a plausible assumption over this long time period. This long time series allows us to examine the short-run and long-run determinants of the shadow economy. Undoubtedly, the incentive to engage in underground work is time dependent, as the costs and benefits differ in the short run compared to the longer run.

This currency demand approach was first used by Cagan (1958), who considered the correlation between currency demand and tax pressure (as one cause of the shadow economy) for the United States over the period 1919 to 1955. Cagan's approach was further developed by Tanzi (1983), who econometrically estimated a currency demand function for the United States for the period 1929 to 1980 in order to calculate the size of the shadow economy.

The measure of the shadow economy that we use in this paper comes from Géidigh et al. (2016) who estimate the U.S. shadow economy using the currency demand approach. The authors used the ratio of currency over M2 as the dependent variable, and the independent variables included the tax burden, measured by the share of total tax burden to GDP, real GDP, interest rate, employment rate, unemployment rate, government expenditure, total welfare expenditure, size of the public sector, fraud (crime), and wages and salaries in the national income.

In Géidigh, et al.'s (2016) paper a number of alternative specifications are tried, but the results are quite robust with respect to different specifications.[9] What is remarkable is that during the Great Depression there was a sharp decline of the shadow economy. One explanation may be that the recession was so severe that even the demand for shadow activities decreased (either directly or via reduced subcontracting). The increase in World War II is plausible and the expansion of the welfare state and additional new taxes again led to an increase in the shadow economy in the 1970s. Since then we had a steady decline in shadow economy which is also supported by other research (see e.g. Williams and Schneider (2016)). In our sample, the average prevalence of the shadow economy in the United States was about 15 percent of GDP.

---

[8] See Alm and Embaye (2013) for cross-national estimates of the shadow economy based on the currency demand method for a limited number of years.

[9] When using this shadow economy series, we are aware of a possible identification or endogeneity problem. Our shadow economy series is constructed using the variables income per capita, interest rate, public sector, tax burden, self-employment, unemployment, fraud incidence, wages in national income, welfare and total expenditure. In our analysis we use size of government, which is closely related to wages in national income and/or income per capita. However, we want to explicitly mention that we did not use the exact same variables as have been used to estimate the size of the shadow economy in the study by Géidigh et al. (2016). Still as these variables have some similarity, but as there is only limited overlapping, we argue that we can still use the following approach.

While the currency demand approach is a useful and intuitive method for calculating the prevalence of the shadow economy, it is not without drawbacks, as noted by Ahumada et al. (2004) and Schneider and Buehn (2016), among other scholars. Major drawbacks of this approach can be summarized as:

(i) Not all transactions in the shadow economy are paid in cash. Hence, the actual size of the total shadow economy may be larger.

(ii) The Currency Demand Approach is only applicable for domestic currency and if a currency is used in other countries (e.g., USD or the Euro) it has to be corrected for such international spread.[10]

(iii) Increases in currency demand deposits are largely caused by a slowdown in demand deposits rather than an increase in currency, again causing a potential discrepancy in calculations.

(iv) Another potential weak point is the assumption of the same velocity of money in both types of economies (official and unofficial).

(v) Ahumada et al. (2004) show that the assumption of the equal income velocity of money in both economies is only correct if income elasticity of currency demand is one.

(vi) Finally, the assumption of no shadow economy in the base year is open to criticism.

We are aware of these limitations, but still we think that the currency demand approach is a useful tool to investigate the size and development of the shadow economy of the United States of almost 150 years. Plus, this approach is widely used in the literature (see, for example, Goel and Nelson (2016)). [11] The other data are from the sources listed in Table 1. The average inflation rate in our sample was about two percent. The estimation procedure(s) outlined below will shed light on the relationship between the shadow economy and its determinants.

3.2 Estimation

Prior to estimation of equation (1), we perform some preliminary tests to test the stationarity properties of our variables over this long time period (see Table 2). To test for unit roots we use the Augmented Dickey-Fuller test under the null that that series contains a unit root. To control for serial correlation lagged first differences are added to the test equation. We set the max number of (annual) lags to 13 and allow the Schwarz Information Criterion (SIC) to choose the optimal lag length. We also report a modified version of the Augmented Dickey-Fuller tests that allows for an endogenously determined structural break.

According to these results, the variables *Shadow*, *OPEN*, *VETOES* and *GDP* contain a unit root in levels and are stationary in first differences, therefore these variables are integrated of order 1 (I(1)). In contrast, *INFL*, *GOVSIZE,* and *NEWSTATES* are stationary in levels and thus integrated

---

[10] It seems plausible that the use of U.S. dollars as a "standard", widely accepted international currency in developing countries in Africa and Asia likely contributed to growth in the world shadow economy. We thank an anonymous referee for pointing this out.

[11] Plus, the absence of estimates of the shadow economy for a comparable time period with other approaches, mainly the MIMIC method, prevents us from doing a comparison for robustness.

of order 0 (I(0)). One thing to note is that many of the endogenously determined structural breaks occur during the Great Depression, World War I or World War II.

Although the variables are of different orders of integration, it is still possible that there exists a stationary long-run, or cointegrated, relationship between the size of the shadow economy and its determinants. To test for the existence of a cointegrated relationship among variables of different orders of integration we use the Bounds testing procedure developed by Pesaran et al. (2001).[12] The Bounds testing procedure requires us to operationalize equation (1) by converting it to an autoregressive distributed lag (ARDL) model:

$$\Delta Shadow_t = \alpha_0 + \sum_{i=1}^{p_1} \gamma_{1i}\Delta Shadow_{t-i} + \sum_{i=1}^{p_2} \gamma_{2i}\Delta GDP_{t-i} + \sum_{i=1}^{p_3} \gamma_{3i}\Delta OPEN_{t-i} +$$
$$\sum_{i=1}^{p_4} \gamma_{4i}\Delta INFL_{t-i} + \sum_{i=1}^{p_5} \gamma_{5i}\Delta GOVSIZE_{t-i} + + \sum_{i=1}^{p_6} \gamma_{6i}\Delta VETOES_{t-i} +$$
$$+ \sum_{i=1}^{p_7} \gamma_{7i}\Delta PARTY_{t-i} + \sum_{i=1}^{p_8} \gamma_{8i}\Delta NEWSTATES_{t-i} + \pi_1 Shadow_{t-1} + \pi_2 GDP_{t-1} +$$
$$\pi_3 OPEN_{t-1} + \pi_4 INFL_{t-1} + \pi_5 VETOES_{t-1} + \pi_6 PARTY_{t-1} + \pi_7 NEWSTATES_{t-1} +$$
$$Shocks_t^j + \varepsilon_t \tag{2}$$

In order to fully capture the underlying dynamics of each endogenous variable in the model and ensure the model is free from serial correlation, we chose to use five lags for the ARDL (p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8) model, such that $p_i=5$ for i=1,…,8. In the absence of serial correlation, lagging the regressors converts them to "predetermined" thus mitigating problems with endogeneity (see Pesaran and Shin (1998) for details). Moreover, in the presence of cointegration, the OLS estimates are super consistent.[13]

Once specified, equation (2) is used to test the null hypothesis of no cointegration ($\pi_1 = \pi_2 = \pi_3 = \pi_4 = \pi_5 = \pi_6 = \pi_7 = \pi_8 = 0$) against the alternative of cointegration ($\pi_1 \neq 0, \pi_2 \neq 0, \pi_3 \neq 0, \pi_4 \neq 0, \pi_5 \neq 0, \pi_6 \neq 0, \pi_7 \neq 0, \pi_8 \neq 0$). This partial F-test is non-standard, thus Pesaran et al. (2001) develop critical values for an upper bound, assuming the variable are all I(0), and a lower bound, assuming all the variables are I(1). If the F-statistic exceeds the upper bound then the null is rejected, if the F-statistic falls below the lower bound then we fail to reject the null, and if the F-statistic falls between the upper and lower bound the test is inconclusive. The results for the Bounds test are reported in Panel B of Table 3. Notice that the F-statistic clearly exceeds the upper bound at the 1% significance level, indicating the variables are indeed cointegrated.

After establishing cointegration we proceed by estimating the ARDL error correction model, which reports the short-run dynamics and the error correction term (ECT).

---

[12] Hajilee et al. (2017) use a similar approach to test for short-run and long-run asymmetric effects of the shadow economy on financial market inclusion for 18 emerging economies.
[13] We suggest that the reader use appropriate caution when interpreting the results given that the dependent variable (*Shadow*) is an estimated variable (for details see Dumont et al. (2005) and Pagan (1984)).

$$\Delta Shadow_t = \alpha_0 + \sum_{i=1}^{p_1} \gamma_{1i}\Delta Shadow_{t-i} + \sum_{i=1}^{p_2} \gamma_{2i}\Delta GDP_{t-i} + \sum_{i=1}^{p_3} \gamma_{3i}\Delta OPEN_{t-i}$$
$$+ \sum_{i=1}^{p_4} \gamma_{4i}\Delta INFL_{t-i} + \sum_{i=1}^{p_5} \gamma_{5i}\Delta GOVSIZE_{t-i} + \sum_{i=1}^{p_6} \gamma_{6i}\Delta VETEOS_{t-i}$$
$$+ \sum_{i=1}^{p_7} \gamma_{7i}\Delta PARTY_{t-i} + \sum_{i=1}^{p_8} \gamma_{8i}\Delta NEWSTATES_{t-i} + \phi_1 ECT_{t-1} + Shocks_t^j$$
$$+ \varepsilon_t \qquad\qquad (3)$$

Where the coefficients on the first differenced variables provide the short-run response of *Shadow* to a short-run change in each determinant. The ECT is the error correction term calculated as the residual from the cointegration equation lagged one period. Thus, the ECT captures disequilibrium and ϕ_1 measures the shadow economy's short-run response to long-run disequilibrium. We also include dummy variables to account for major shocks that occur during this period including World War I (1914-1918), The Great Depression (1929-1939), and World War II (1939-1945).[14]

3.3 Diagnostic tests

To ensure the model is correctly specified we report several diagnostic tests. First, the Q-statistic, under the null of no serial correlation, is reported at 36 annual lags and the high p-value suggests that the residuals are free from serial correlation. Second, we report two tests for heteroscedasticity, the Breusch-Pagan-Godfrey test and White test. Both tests fail to reject homoscedasticity, although the former test is only marginally insignificant. Moreover, the insignificance of the ARCH test indicates the residuals are free from conditional heteroscedasticity. Furthermore, the insignificance of the Jarque-Bera test for normality suggests that the errors are normally distributed, and the insignificance of the Ramsey RESET test is consistent with the absence of model misspecification. Overall, these diagnostic tests suggest the model is correctly specified.

Finally, to check for parameter stability, we follow Pesaran and Pesaran (1997) and report the cumulative sum (CUSUM) and the cumulative sum of square (CUSUMSQ) tests of the recursive residuals developed by Brown et al. (1975). The CUSUM test is useful for detecting systematic changes in parameter stability, whereas the CUSUMSQ test is useful when the changes are abrupt. Figures 2 and 3 report the results for the CUSUM and CUSUMSQ test, respectively. The CUSUM clearly falls within the critical lines consistent with parameter stability; however, the CUSUMSQ test shows some evidence of parameter instability from abrupt changes.

---

[14] Although the U.S. was likely influenced by the world wars earlier, the U.S. did not officially enter into WWI until 1917 and WWII until 1941. To account for possible timing issues related to this, we re-estimated the model restricting the relevant dummy variables accordingly. Likewise, some could argue that the Great Depression ended earlier (e.g. The NBER referenced the peak at 1929, the trough at 1933, and the following peak at 1937). Thus, we restricted the depression dummy to 1929-1937. The results with these updated dummy variables showed overall consistency with our main model estimates; however, the *WWII* was marginally insignificant, and *OPEN* as well as *GOVSIZE* became marginally insignificant. Results are available upon request.

4. Results

Table 3 reports the long-run estimates (Panel A) and corresponding Bounds test for cointegration (Panel B). Panel A of Table 3 shows that among economic factors, openness to trade and government size decreased the U.S. shadow economy, with the effects of GDP and inflation being statistically insignificant.[15] In terms of elasticity (evaluated at mean values - see Table 1), a 1% increase in *OPEN* and *GOVSIZE* decrease the shadow economy by 0.92% and 0.80%, respectively. A larger government through, for example, better enforcement/surveillance, acted as a check against expanding formal economies.[16] Greater openness to trade made foreign firms ready competitors and these firms likely took away some of the work from domestic informal operators.

Among political influences, both variables (*VETOES* and *PARTY*) have a negative sign; however, only *PARTY* is statistically significant. Thus, the shadow economy contracts when the U.S. House and the Senate are held by the same political party by making it easier to pass legislation that combats shadow activities. Likewise, congressional party homogeneity also make it easier to pass legislation that might benefit the formal economy and thus raise the opportunity costs of producing underground. Furthermore, a unified Congress presents a more credible deterrence threat to potential lawbreakers. Finally, adding new states (*NEWSTATES*) to the union has a positive influence on the size of the U.S. shadow economy in the long run. This is consistent with new states enhancing opportunities for shadow operations over the long term.

Table 4 presents the short-run dynamics represented by the lagged first differences of each variable and the error correction term. The coefficient on the error correction term captures the short-run response to long-run disequilibrium, where the magnitude provides the speed of adjustment to long-run equilibrium. Consistent with a dynamically stable cointegrating relationship, the coefficient on the error correction term is negative and significant. The speed of the adjustment back to long-run equilibrium takes approximately five years.[17] Interestingly, this coincides with the approximate length of business cycles from 1945-2009 calculated by NBER.[18]

The short-run influence of changes in the shadow economy have no significant effect on the contemporaneous size of the shadow economy. The short-run effect for *GDP*, similar with the long-run effect, are insignificant, however, the (mostly) negative coefficients are consistent with the counter-cyclical nature of the shadow economy. Whereas inflation has an insignificant effect on shadow in the long-run, the short-run coefficients (period t) shows a negative and statistically significant effect on the shadow economy. For instance, monetary illusion created by higher inflation increases nominal earnings and raises the real tax burden, known as fiscal drag (see Dell'Anno and Dollery (2014)). Interestingly, both *OPEN* and *GOVSIZE* have opposite effects in the short run compared to the long run. In the short run, greater openness to trade increases

---

[15] The rate of interest used in the construction of currency demand to capture the opportunity of holding cash may potentially be distorting the effect of inflation on the shadow economy. However, our use of an alternate measure of the shadow economy as a robustness check somewhat mitigates these concerns.

[16] Using data from transition countries, Eilat and Zinnes (2002) find a similar negative relation between tax burden and the shadow economy, and no significant effect of tax rates.

[17] Speed of adjustment is calculated as the reciprocal of the coefficient on the error correction term.

[18] See http://www.nber.org/cycles.html

competition, encouraging firms to migrate underground to lower costs to better compete with foreign firms. The lagged effect of government size is positive and significant at lags t-3, consistent with a larger government (high taxes, bureaucratic red tape and regulations) being a driver of shadow activity. Turning to the short-run influence of the political variable, *VETOES* has no appreciable statistical effect, however, *PARTY* has a positive and significant effect on the U.S. shadow economy at lags t-1. Finally, at lag t-4, the short-run effect of new states added to the union (*NEWSTATES*) has a negative and statistically significant effect on the shadow economy. The negative short run effect of the *NEWSTATES* can be seen consistent with initial governance zeal and dismantling of old shadow networks with territorial expansion, whereas in the short term party homogeneity in the congress is likely unable to credibly convey enforcement resolve.

There are remarkable differences in the effect of some variables on the shadow economy between the short run and long run. First, the negative influence of inflation on the shadow economy in the short run is likely a result of individuals switching to barter trade as a hedge against inflation, which would show a decline in the shadow economy when measured by currency demand.

Further, the effect of trade openness is positive in the short run as domestic firms move underground to lower costs to effectively deal with foreign competition; however, the in long run trade openness contributes to the transformation of institutions, new markets, and, ultimately more economic freedom that raises the opportunity cost of producing underground.

Finally, a larger government sector in the short run (Table 4) is consistent with greater subcontracting expanding the underground sector. In contrast, a larger government in the long run (Table 3) is consistent with government looking to combat the shadow economy (by, for example, findings ways to plug holes in effectively monitoring underground activities). This negative influence over time might also be due learning to effectively combat the underground sector over time. Moreover, given the difference between the short run and long run effects of government it is conceivable that the fall in the individual income tax rates and deregulation over the last fifty years dominates the continued rise in government spending, thus prompting a fall in shadow activity.[19]   Also, the change in House and Senate homogeneity has a positive effect on the shadow economy in the short run. Overall, the results of this analysis reveal that the shadow economy is quite dynamic and the effects of determinants vary over time.

Additionally, the external shock of World War II increased the shadow sector, while World War I has no significant influence. Further, the Great Depression reduced the shadow economy. The effects of the World War II are consistent with the urgency of producing during war times, especially with foreign supplies being cut off that opened opportunities for underground operators.[20]   Interestingly, the magnitude of WWII dummy is greater than that of WWI,

---

[19] The aggregate measure of government spending used in the analysis also masks the composition of spending (i.e. move from military spending to social insurance) that likely affects the shadow economy over the long term.
[20] Wars also likely resulted in lax enforcement of underground activities.

consistent with Figure 1.[21] On the other hand, the reduced economic activity during the great depression lowered opportunities for both the formal and the informal sectors.[22]

Overall, the determinants of the shadow economy have somewhat different effects in the short run relative to the long run.[23] While we have been able to account for many economic and political factors in the analysis, the nature of the shadow economy and its drivers might have qualitatively changed over the long time period considered, with some of these factors not being easily quantifiable (see Goel and Nelson (2016) for robustness analysis of the drivers of the shadow economy, albeit based on cross-country data over a short period of time). Table 5 includes a summary of the hypotheses and corresponding empirical findings. These findings reveal the importance of accounting for the time dimension when examining the determinants of the shadow economy.

5. Conclusions

This paper examines the determinants of the shadow economy in the United States. Key contributions include a look at the shadow economy over nearly a century and a half, consideration of political factors, geographic factors, and the influences of the world wars and the Great Depression. The long time span also enables us to account for the drivers of persistence or hysteresis in the prevalence of the underground sector (see Eilat and Zinnes (2002)). Furthermore, the flexibility in the ARDL estimation model enables us to observe the influence of shadow determinants in both the long run as well as the short-run dynamics including adjustment to long-run equilibrium.

After performing a battery of diagnostic time series tests, results show that interesting economic, political and external influences on the long term spread of the U.S. shadow economy (Table 3). Specifically, among economic factors, greater openness to foreign trade and a larger government lowered the shadow economy, while GDP had no significant influence on it, as did the rate of inflation. Among political factors, a strong presidency, as captured by the annual presidential vetoes, is statistically insignificant, whereas party homogeneity significantly reduced the size of the shadow economy. Changes in the state of the union with the addition of new states increased the size of the shadow economy. Our consideration of political and geographic factors is unique in the extant literature. Finally, the influences of three external shocks considered, World War II increased the underground sector and the Great Depression reduced it. A summary of the validity of the various hypotheses is provided in Table 5.

---

[21] Appropriate caution needs to be exercised in interpreting coefficients on dummy variables.

[22] Although other factors likely influence the shadow economy over such a long time period, we are constrained by data availability over this period.
As one additional robustness check, we included a dummy variable for the years during prohibition (1920-1933) and re-estimated the baseline model. The coefficient on prohibition is negative albeit insignificant, and the remaining variables are consistent with the baseline results. Thus, the years of prohibition failed to significantly affect the overall shadow economy in the United States. These results are available upon request

[23] Goel et al. (2017) focus on how U.S. economic growth is affected by the shadow economy, employing a similar underlying econometric methodology.

Turning to the short-run influence of these variables (Table 4), the results suggest some remarkable differences. That is, greater openness to foreign trade and a large government worked to increase the size of the shadow economy in the short run, while higher inflation reduced it. The heightened competitive pressures with foreign trade openness likely increased shadow economy via greater subcontracting (to lower costs), while greater inflation had the reverse effect by making such subcontracting more expensive.

One policy implication of these findings is that policymakers need to be patient to allow the effects of certain actions to unravel over time. For instance, our results show that a larger government checks the underground sector over time, while it might initially increase it. Finally, paying attention to the changing composition of the American union, the influence of new states added to the union reduces the size of the shadow economy in the short run (unlike the long run). These influences on the underground sector from the changing composition of the country were likely unforeseen by lawmakers.

While some of the factors, especially economic factors, have been found to significant affect shadow economies for the United States and elsewhere in the past (Goel and Nelson (2016), Goel and Saunoris (2016a), Schneider (2012), Schneider and Enste (2000)), other contributions noted in this work are new. These findings are instructive for formulation of long term policies in tackling the underground sector as well as short term contingencies necessitated by occasional, unexpected shocks.

References

Alm, J., Embaye, A., 2013. Using dynamic panel methods to estimate shadow economies around the world, 1984-2006. Public Finance Review, 41(5), 510-543.

Ahumada, H., Alvaredo, F., Canavese, A.J., 2006. The demand for currency approach and the size of the shadow economy: A critical assessment. Berkeley Program in Law and Economics, Working Paper Series, https://escholarship.org/uc/item/6zn9p98b

Berdiev, A.N., Pasquesi-Hill, C., Saunoris, J.W., 2015. Exploring the dynamics of the shadow economy across US states. Applied Economics, 47(56), 6136-6147.

Berdiev, A.N., Saunoris, J.W., 2016. Financial development and the shadow economy: A panel VAR analysis. Economic Modelling, 57, 197-207.

Brown, R.L., Durbin, J., Evans, J.M., 1975. Techniques for testing the constancy of regression relationships over time. Journal of the Royal Statistical Society, Series B, 37(2), 149-192.

Buehn, A., Schneider, F., 2012. Shadow economies around the world: Novel insights, accepted knowledge, and new estimates. International Tax and Public Finance, 19(1), 139-171.

Busato, F., Chiarini, B., Marchetti, E., 2011. Indeterminacy, underground activities and tax evasion. Economic Modelling, 28, 831-844.

Cagan, P., 1958. The demand for currency relative to total money supply. Journal of Political Economy, 66(4), 302-328.

Cebula, R.J., Hall, J.C., Mixon, Jr., F.G., Payne, J.E. (eds.), 2015. Economic Behavior, Economic Freedom, and Entrepreneurship. Cheltenham, UK: Edward Elgar.

Dell'Anno, R., Dollery, B.E., 2014. Comparative fiscal illusion: A fiscal illusion index for the European Union. Empirical Economics, 46(3), 937-960.

Djankov, S., La Porta, R., Lopez-De-Silanes, F., Shleifer, A., 2002. The regulation of entry. Quarterly Journal of Economics, CXVII(1), 1-37.

Do, Q-T, Levchenko, A.A., 2009. Trade, inequality, and the political economy of institutions. Journal of Economic Theory, 144(4), 1489-1520.

Dreher, A., Kotsogiannis, C., McCorriston, S., 2009. How do institutions affect corruption and the shadow economy? International Tax and Public Finance, 16, 773-796.

Dumont, M., Rayp, G. Thas, O., Willemè, P., 2005. Correcting standard errors in two-stage estimation procedures with generated regressands. Oxford Bulletin of Economics and Statistics, 67(3), 421-433.

Eilat, Y., Zinnes, C., 2002. The shadow economy in transition countries: Friend or foe? A policy perspective. World Development, 30(7), 1233-1254.

Engle, R.F., Granger, C.W.J., 1987. Co-integration and error correction: Representation, estimation, and testing. Econometrica, 55(2), 251-276.

Frey, B.S., Weck-Hannemann, H., 1984. The hidden economy as an 'unobserved' variable. European Economic Review, 26(1-2), 33-53.

Friedman, E., Johnson, S., Kaufmann, D., Zoido-Lobatón, P., 2000. Dodging the grabbing hand: The determinants of unofficial activity in 69 countries. Journal of Public Economics, 76(3), 459-493.

Géidigh, D.M., Schneider, F., Blum, M., 2016. Grey matters: Charting the development of the shadow economy. CESifo working paper #6234, December.

Gërxhani, K., 2004. The informal sector in developed and less developed countries: A literature survey. Public Choice, 120(3-4), 267-300.

Goel, R.K., Nelson, M.A., 2016. Shining a light on the shadows: Identifying robust determinants of the shadow economy. Economic Modelling, 58, 351-364.

Goel, R.K., Saunoris, J.W., 2014. Global corruption and the shadow economy: Spatial aspects. Public Choice, 161(1-2), 119-139.

Goel, R.K., Saunoris, J.W., 2016a. Casting a long shadow? Cross-border spillovers of shadow economy across American states. Public Finance Review, 44(5), 610-634.

Goel, R.K., Saunoris, J.W., 2016b. Government decentralization and prevalence of the shadow economy. Public Finance Review. 44(5), 263-288.

Goel, R.K., Saunoris, J.W., Schneider, F., 2017. Growth in the shadows: Effect of the shadow economy on US economic growth over more than a century. Contemporary Economic Policy, forthcoming.

Hajilee, M., Stringer, D.Y, Metghalchi, M., 2017. Financial market inclusion, shadow economy and economic growth: New evidence from emerging economies. The Quarterly Review of Economics and Finance, 66, 149-158.

Hall, J.C., Lawson, R.A., 2014. Economic freedom of the world: An accounting of the literature. Contemporary Economic Policy, 32(1), 1-19.

Johansen, S., Juselius, K., 1990. Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52(2), 169-210.

Johnston, L., Williamson, S.H., 2017. What was the U.S. GDP then? MeasuringWorth. https://www.measuringworth.com/

Kirchgässner, G., 2017. On estimating the size of the shadow economy. German Economic Review, 18(1), 99-111.

MacKinnon, J.G., 1996. Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics,* 11(6), 601-618.

Neck, R., Wächter, J.U., Schneider, F., 2012. Tax avoidance versus tax evasion: On some determinants of the shadow economy. International Tax and Public Finance, 19, 104-117.

Pagan, A., 1984. Econometric issues in the analysis of regressions with generated regressors. International Economic Review, 25(1), 221-247.

Pesaran, M.H., Pesaran, B., 1997. Working with Microfit 4.0: Interactive Econometric Analysis. Oxford: Oxford University Press.

Pesaran, M.H., Shin, Y., 1998. An autoregressive distributed lag modelling approach to cointegration analysis. Econometrics Society Monographs, 31, 371-413.

Pesaran, M.H., Shin, Y., Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326.

Restrepo-Echavarria, P., 2015. Measuring underground economy can be done, but it is difficult. The Regional Economist, January, 10-11. www.stlouisfed.org

Schneider, F., 2003. Shadow Economy. In: C.K. Rowley and F. Schneider (eds.), Encyclopedia of Public Choice, Vol. II, Dordrecht: Kluwer Academic Publishers, pp. 286-296.

Schneider, F., 2005. Shadow economies around the world: What do we really know? European Journal of Political Economy, 21, 598-642.

Schneider, F., 2012. The shadow economy and work in the shadow: What do we (not) know? IZA Discussion Paper No. 6423.

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

Schneider, F., Buehn, A., 2013. Estimating the size of the shadow economy: Methods, problems and open questions. CESifo working paper #4448.

Schneider, F., Buehn, A., 2016. Estimating the size of the shadow economy: Methods, problems and open questions. IZA Discussion Paper No. 9820, March.

Schneider, F., Buehn, A., C.E. Montenegro, C.E., 2010. New estimates for the shadow economies all over the world. International Economic Journal, 24, 443-461.

Schneider, F., Enste, D.H., 2000. Shadow economies: Size, causes, and consequences. Journal of Economic Literature, 38, 77-114.

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

Tanzi, V., 1983. The underground economy in the United States: Annual estimates, 1930-1980, IMF Staff Papers, 30(2), 283-305.

Vogelsang, T.J., 1993. Unpublished computer program.

Table 1: Variable definitions, summary statistics and data sources

Variable	Definition	Mean	S.D.	Min	Max
Shadow	The size of the shadow economy (% of GDP), using the currency demand method. Source: Géidigh et al. (2016)	15.3625	6.7725	5.4000	36.9000
Shadow2	The size of the shadow economy (% of GDP), using the currency demand method. Compiled using the Géidigh et al. (2016) measure from 1870 to 1935 and the Tanzi (1983) measure from 1936 to 2015. Source: Géidigh et al. (2016) and Tanzi (1983)	10.2239	8.2935	0.4462	36.9000
GDP	The log of real GPD per capita (constant 2009 $). Source: Johnston and Williamson (2017)	9.4297	0.8459	8.0196	10.8057
INFL	Inflation rate measured as the percent change in the GDP deflator. Source: Johnston and Williamson (2017)	2.0405	4.5652	-14.7377	23.3240
OPEN	Trade openness measured as the sum of imports and exports divided by nominal GDP. Source: Jordà et al. (2017) & authors' calculations	0.1163	0.0448	0.0499	0.2414
GOVSIZE	Government expenditures as a fraction of GDP. Source: Jordà et al. (2017) & authors' calculations	0.1191	0.0897	0.0142	0.4065
VETOES	Total congressional bills vetoed per 100,000,000 population. Source: http://www.senate.gov/	114.1841	166.0997	0	734.6884
PARTY	Dummy variable =1 if the majority party in the House of Representatives and the Senate is the same and zero otherwise. Source: http://clerk.house.gov	0.793103	0.406485	0	1
NEWSTATES	The number of states in the union in a given year. New states that entered the union after 1870 include: Colorado (1876), North Dakota (1889), South Dakota (1889), Montana (1889), Idaho (1890), Wyoming (1890), Utah (1896), Oklahoma (1907), New Mexico (1912), Arizona (1912), Alaska (1959), and Hawaii (1959).	46.85759	4.111881	37	50
Depression	Dummy variable equal to one for the years covering the Great Depression (1929-1939), and zero otherwise.				
WWI	Dummy variable equal to one for the years covering World War I (1914-1918), and zero otherwise.				
WWII	Dummy variable equal to one for the years covering World War II (1939-1945), and zero otherwise.				

Note: The data include annual observations for the United States from 1870 to 2014, unless otherwise specified.

Table 2: Drivers of the underground economy -Unit Root Tests: Augmented Dickey-Fuller

Variable	ADF[a]	ADF-break point test[b]
Shadow	-1.78 [0.389]	-2.44 [0.917] Break Date: 1943
ΔShadow	-11.62*** [0.000]	-12.24*** [<0.01]
GDP	-0.55 [0.878]	-3.37 [0.463] Break Date: 1933
ΔGDP	-8.92*** [0.000]	-9.63*** [<0.01]
INFL	-6.31*** [0.000]	-7.57*** [<0.01] Break Date: 1917
OPEN	0.52 [0.987]	-2.38 [0.932] Break Date: 1986
ΔOPEN	-11.33*** [0.000]	-12.37*** [<0.01]
GOVSIZE	-3.02** [0.035]	-7.63*** [<0.01] Break Date: 1941
VETOES	-2.54 [0.109]	-3.24 [0.545] Break Date: 1944
ΔVETOES	-9.55*** [0.000]	-14.23*** [<0.01]
NEWSTATES	-2.70* [0.076]	-6.07*** [<0.01] Break Date: 1888

Notes: Schwartz Information Criterion (SIC) used to determine optimal lag length with a max lag length of 13.
a. MacKinnon (1996) one-sided p-values are in brackets.
b. Vogelsang (1993) asymptotic one-sided p-values in brackets.
*Asterisks denote the following significance levels: *** p<0.01*

Table 3: Drivers of the underground economy - Cointegration test: Bounds testing procedure

Panel A: Cointegration estimates				
	Coefficient	Standard Error	Probability Values	
GDP	-0.0676	7.4997	0.9928	
INFL	-0.9114	0.9223	0.3257	
OPEN	-121.3862*	72.9673	0.0998	
GOVSIZE	-102.9122*	59.4550	0.0870	
VETOES	-0.0061	0.0140	0.6619	
PARTY	-12.5928**	5.2346	0.0182	
NEWSTATES	2.0516**	0.9516	0.0338	
C	-39.6342	42.9834	0.3590	
Panel B: Bounds tests for cointegration				
H$_0$: No cointegration				
F(*Shadow* | *GDP*, *INFL*, *OPEN*, *GOVSIZE*, *VETOES*, *PARTY*, *NEWSTATE*) (k=6) 3.93***				

*Notes: Asterisks denote the following significance levels: *** $p<0.01$, ** $p<0.05$, and * $p<0.1$. C is constant term and the other variables are defined in Table 1. Critical value bounds for the bounds testing with intercept and no trend and k=7 are:*

Significance	I(0) Bound	I(1) Bound
10%	1.92	2.89
5%	2.17	3.21
1%	2.73	3.90

Table 4: Drivers of the underground economy - ARDL Error-Correction Model

	Coefficient	Standard Error	P-value	
$\Delta Shadow_{t-1}$	-0.0483	0.0902	0.5934	
$\Delta Shadow_{t-2}$	0.0179	0.0888	0.8410	
$\Delta Shadow_{t-3}$	0.1455	0.0898	0.1086	
$\Delta Shadow_{t-4}$	0.0752	0.0894	0.4025	
ΔGDP_t	-3.1159	4.0912	0.4483	
ΔGDP_{t-1}	0.1559	4.2386	0.9707	
ΔGDP_{t-2}	-6.9639	4.3134	0.1100	
ΔGDP_{t-3}	-2.3903	4.2843	0.5783	
ΔGDP_{t-4}	-2.1518	4.4208	0.6277	
$\Delta INFL_t$	-0.1194*	0.0675	0.0805	
$\Delta INFL_{t-1}$	0.0736	0.0618	0.2372	
$\Delta INFL_{t-2}$	-0.0182	0.0646	0.7787	
$\Delta INFL_{t-3}$	-0.0726	0.0617	0.2429	
$\Delta INFL_{t-4}$	0.0891	0.0563	0.1170	
$\Delta OPEN_t$	30.8765*	16.8680	0.0706	
$\Delta OPEN_{t-1}$	63.6641***	19.0471	0.0012	
$\Delta OPEN_{t-2}$	52.9111***	19.7513	0.0088	
$\Delta OPEN_{t-3}$	59.7163***	19.6776	0.0032	
$\Delta OPEN_{t-4}$	38.0691*	19.2122	0.0507	
$\Delta GOVSIZE_t$	1.3469	9.0781	0.8824	
$\Delta GOVSIZE_{t-1}$	6.2783	9.7035	0.5193	
$\Delta GOVSIZE_{t-2}$	-6.0459	9.3474	0.5194	
$\Delta GOVSIZE_{t-3}$	24.2277***	8.7491	0.0069	
$\Delta GOVSIZE_{t-4}$	10.6568	8.3018	0.2026	
$\Delta VETEOS_t$	-0.0030	0.0024	0.2171	
$\Delta VETEOS_{t-1}$	0.0013	0.0021	0.5330	
$\Delta VETEOS_{t-2}$	0.0010	0.0021	0.6540	
$\Delta VETEOS_{t-3}$	0.0012	0.0020	0.5652	
$\Delta VETEOS_{t-4}$	-0.0020	0.0023	0.3926	
$\Delta PARTY_t$	-0.7456	0.5731	0.1966	
$\Delta PARTY_{t-1}$	1.8936***	0.6289	0.0034	
$\Delta PARTY_{t-2}$	0.6323	0.6675	0.3461	
$\Delta PARTY_{t-3}$	0.4947	0.6657	0.4594	
$\Delta PARTY_{t-4}$	0.3603	0.6773	0.5961	
$\Delta NEWSTATES_t$	-0.0849	0.4113	0.8370	
$\Delta NEWSTATES_{t-1}$	-0.2956	0.4345	0.4981	
$\Delta NEWSTATES_{t-2}$	-0.3908	0.4347	0.3711	
$\Delta NEWSTATES_{t-3}$	-0.1278	0.4334	0.7688	
$\Delta NEWSTATES_{t-4}$	-0.9095**	0.4314	0.0378	
WWI	0.4683	1.0814	0.6661	
$WWII$	2.2952**	1.1092	0.0415	
$Depression$	-2.4347***	0.7371	0.0014	
ECT_{t-1}	-0.1996***	0.0321	0.0000	

Diagnostic tests			
Q-Stat (36)	37.32	[0.408]	
Jarque-Bera test	1.36	[0.507]	
Breusch-Pagan-Godfrey test	1.36	[0.106]	
White test	1.15	[0.284]	
ARCH test (3 lags)	2.05	[0.110]	
Ramsey RESET test	0.84	[0.404]	

*Note: Asterisks denote the following significance levels: *** p<0.01, ** p<0.05, and * p<0.1. ECT_{t-1} is the error correction term, which captures deviations from the long-run equilibrium; The other variables are defined in Table 1.*

Table 5: Summary of the empirical findings

Hypothesis	**Description**	**Findings (sign of effect)**
H1	*No clear-cut hypothesis about the effect of the size of government on the shadow economy.*	Long run: (-) Short run: (+)
H2	*The higher the inflation rate, the higher is the shadow economy, ceteris paribus.*	Long run: Not significant Short run: (-)
H3	*The effect of GDP on the shadow economy would be positive if the subcontracting effect is dominant and negative if the institutional improvement effect dominates, ceteris paribus.*	Long run: Not significant Short run: Not significant
H4	*No clear-cut hypothesis about the effect of trade-openness on the shadow economy.*	Long run: (-) Short run: (+)
H5	*No clear-cut hypothesis about the effect of bills vetoed and same political party on the shadow economy.*	Long run: (-) (*PARTY*) Short run: (+) (*PARTY*)
H6	*No clear-cut hypothesis about the effect of expanding the union on the shadow economy.*	Long run: (+) Short run: (-)
H7	*The more intense exogenous shocks like wars, the higher is the shadow economy, ceteris paribus.*	(+) (Confirmed)

Figure 2: CUSUM test for parameter stability

Legend: CUSUM —— 5% Significance -----
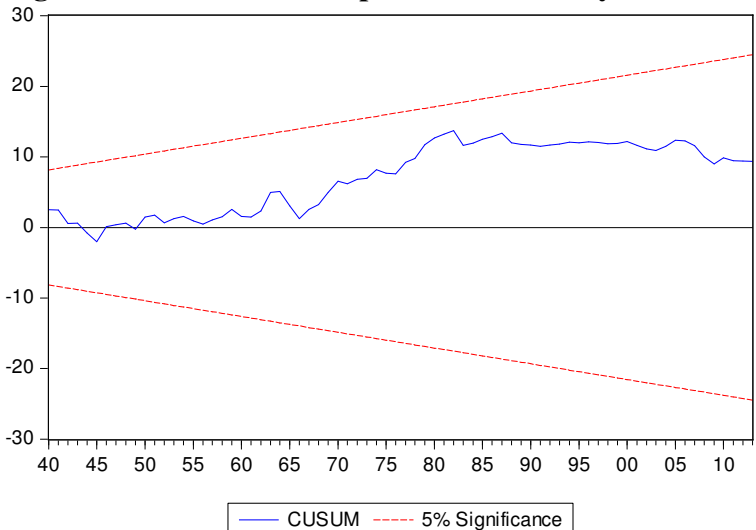
Figure 3: CUSUMSQ test for parameter stability

Legend: CUSUM of Squares —— 5% Significance -----
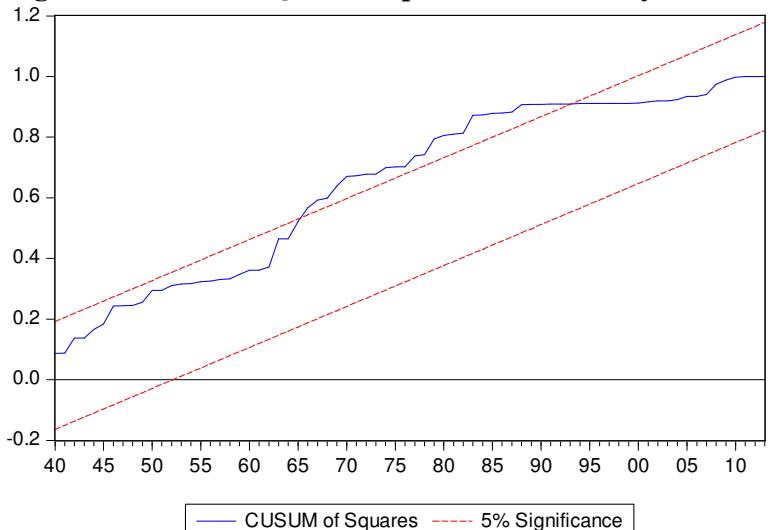
Appendix: Robustness check with an alternate measure of the shadow economy (*Shadow2*)

Table 3A: Drivers of the underground economy - Cointegration test: Bounds testing procedure using alternate measure of the shadow economy (*Shadow2*)

Panel A: Cointegration estimates				
	Coefficient	Standard Error	Probability Values	
GDP	2.5141	7.9961	0.7539	
INFL	-0.4342	0.5870	0.4614	
OPEN	-1147.2100	62315.6600	0.9854	
GOVSIZE	-162289.9000**	72040.8300	0.0268	
VETOES	-0.0074	0.0164	0.6532	
PARTY	-7.8999	4.9347	0.1130	
NEWSTATES	1.2500	0.9778	0.2045	
C	-41.3018	45.3397	0.3648	
Panel B: Bounds tests for cointegration				
H_0: No cointegration				
F(*Shadow | GDP, INFL, OPEN, GOVSIZE, VETOES, PARTY, NEWSTATE*) (k=7) 3.23**				

*Notes: Asterisks denote the following significance levels: *** $p<0.01$, ** $p<0.05$, and * $p<0.1$. C is constant term and the other variables are defined in Table 1. Critical value bounds for the bounds testing with intercept and no trend and k=7 are:*

Significance	I(0) Bound	I(1) Bound
10%	1.92	2.89
5%	2.17	3.21
1%	2.73	3.90

Table 4A: Drivers of the underground economy - ARDL Error-Correction Model –
Shadow2

	Coefficient	Standard Error	P-value	
$\Delta Shadow_{t-1}$	-0.1256	0.0871	0.1526	
$\Delta Shadow_{t-2}$	0.0796	0.0751	0.2918	
$\Delta Shadow_{t-3}$	0.1777**	0.0793	0.0276	
$\Delta Shadow_{t-4}$	0.2420***	0.0852	0.0056	
ΔGDP_t	-11.2435***	3.2450	0.0008	
ΔGDP_{t-1}	-8.6149**	3.5788	0.0182	
ΔGDP_{t-2}	-10.6637***	3.6738	0.0047	
ΔGDP_{t-3}	-2.9064	3.5155	0.4106	
ΔGDP_{t-4}	7.2441**	3.5902	0.0467	
$\Delta INFL_t$	-0.0891	0.0557	0.1136	
$\Delta INFL_{t-1}$	0.0382	0.0508	0.4535	
$\Delta INFL_{t-2}$	-0.1694***	0.0520	0.0016	
$\Delta INFL_{t-3}$	-0.2068***	0.0509	0.0001	
$\Delta INFL_{t-4}$	-0.0076	0.0473	0.8720	
$\Delta OPEN_t$	13868.3000	13348.6200	0.3017	
$\Delta OPEN_{t-1}$	14515.4300	13879.7500	0.2985	
$\Delta OPEN_{t-2}$	43586.5300***	14090.6800	0.0027	
$\Delta OPEN_{t-3}$	31600.7600**	14901.0300	0.0368	
$\Delta OPEN_{t-4}$	16478.0700	14266.4200	0.2512	
$\Delta GOVSIZE_t$	-2743.4870	8180.4130	0.7381	
$\Delta GOVSIZE_{t-1}$	21227.2800**	9022.9130	0.0209	
$\Delta GOVSIZE_{t-2}$	-3350.5030	7757.2590	0.6669	
$\Delta GOVSIZE_{t-3}$	13690.8200*	7079.1010	0.0563	
$\Delta GOVSIZE_{t-4}$	3996.6650	6584.7220	0.5454	
$\Delta VETEOS_t$	-0.0075***	0.0019	0.0001	
$\Delta VETEOS_{t-1}$	0.0005	0.0017	0.7792	
$\Delta VETEOS_{t-2}$	0.0025	0.0017	0.1454	
$\Delta VETEOS_{t-3}$	-0.0030*	0.0017	0.0714	
$\Delta VETEOS_{t-4}$	-0.0051**	0.0020	0.0118	
$\Delta PARTY_t$	-0.1310	0.4553	0.7742	
$\Delta PARTY_{t-1}$	1.4444***	0.4973	0.0046	
$\Delta PARTY_{t-2}$	0.3645	0.5312	0.4944	
$\Delta PARTY_{t-3}$	-0.4455	0.5478	0.4183	
$\Delta PARTY_{t-4}$	0.0275	0.5632	0.9612	
$\Delta NEWSTATES_t$	-0.0580	0.3387	0.8644	
$\Delta NEWSTATES_{t-1}$	-0.0940	0.3618	0.7956	
$\Delta NEWSTATES_{t-2}$	-0.1703	0.3465	0.6243	
$\Delta NEWSTATES_{t-3}$	-0.4281	0.3499	0.2243	
$\Delta NEWSTATES_{t-4}$	-1.0289***	0.3475	0.0039	
WWI	0.8113	0.9057	0.3728	
$WWII$	3.8023***	1.0177	0.0003	
$Depression$	-1.9791***	0.5713	0.0008	

ECT_{t-1}	-0.1539***	0.0273	0.0000	
Diagnostic tests				
Q-Stat (36)	61.88***	[0.005]		
Jarque-Bera test	57.17***	[0.000]		
Breusch-Pagan-Godfrey test	3.76***	[0.000]		
White test	2.68***	[0.000]		
ARCH test (3 lags)	1.44	[0.235]		
Ramsey RESET test	8.28***	[0.005]		

Note: Asterisks denote the following significance levels: *** p<0.01, ** p<0.05, and * p<0.1. ECT_{t-1} is the error correction term, which captures deviations from the long-run equilibrium; The other variables are defined in Table 1.

Table 1A: Political composition of the U.S. Congress over time

Year	President	Vetoes	Congress	House of Rep.	Senate	Party	Year	President	Vetoes	Congress	House of Rep.	Senate	Party
				Majority Party							**Majority Party**		
1870	Ulysses S. Grant	93	41	R	R	Same	1945	Harry S. Truman	250	79	D	D	Same
1871	Ulysses S. Grant	93	42	R	R	Same	1947	Harry S. Truman	250	80	R	R	Same
1873	Ulysses S. Grant	93	43	R	R	Same	1949	Harry S. Truman	250	81	D	D	Same
1875	Ulysses S. Grant	93	44	D	R	Not Same	1951	Harry S. Truman	250	82	D	D	Same
1877	Rutherford B. Hayes	13	45	D	R	Not Same	1953	Dwight D. Eisenhower	181	83	R	R	Same
1879	Rutherford B. Hayes	13	46	D	D	Same	1955	Dwight D. Eisenhower	181	84	D	D	Same
1881	James A. Garfield	0	47	R	R	Same	1957	Dwight D. Eisenhower	181	85	D	D	Same
1883	Chester A. Arthur	12	48	D	R	Not Same	1959	Dwight D. Eisenhower	181	86	D	D	Same
1885	Grover Cleveland	414	49	D	R	Not Same	1961	John F. Kennedy	21	87	D	D	Same
1887	Grover Cleveland	414	50	D	R	Not Same	1963	Lyndon B. Johnson	30	88	D	D	Same
1889	Benjamin Harrison	44	51	R	R	Same	1965	Lyndon B. Johnson	30	89	D	D	Same
1891	Benjamin Harrison	44	52	D	R	Not Same	1967	Lyndon B. Johnson	30	90	D	D	Same
1893	Grover Cleveland	170	53	D	D	Same	1969	Richard M. Nixon	43	91	D	D	Same
1895	Grover Cleveland	170	54	R	R	Same	1971	Richard M. Nixon	43	92	D	D	Same
1897	William McKinley	42	55	R	R	Same	1973	Richard M. Nixon	43	93	D	D	Same
1899	William McKinley	42	56	R	R	Same	1975	Gerald R. Ford	66	94	D	D	Same
1901	Theodore Roosevelt	82	57	R	R	Same	1977	Jimmy Carter	31	95	D	D	Same
1903	Theodore Roosevelt	82	58	R	R	Same	1979	Jimmy Carter	31	96	D	D	Same
1905	Theodore Roosevelt	82	59	R	R	Same	1981	Ronald W. Reagan	78	97	D	R	Not Same
1907	Theodore Roosevelt	82	60	R	R	Same	1983	Ronald W. Reagan	78	98	D	R	Not Same
1909	William H. Taft	39	61	R	R	Same	1985	Ronald W. Reagan	78	99	D	R	Not Same
1911	William H. Taft	39	62	D	R	Not Same	1987	Ronald W. Reagan	78	100	D	D	Same
1913	Woodrow Wilson	44	63	D	D	Same	1989	George Bush	44	101	D	D	Same
1915	Woodrow Wilson	44	64	D	R	Not Same	1991	George Bush	44	102	D	D	Same
1917	Woodrow Wilson	44	65	D	R	Not Same	1993	William J. Clinton	37	103	D	D	Same
1919	Woodrow Wilson	44	66	R	R	Same	1995	William J. Clinton	37	104	R	R	Same
1921	Warren Harding	6	67	R	R	Same	1997	William J. Clinton	37	105	R	R	Same
1923	Calvin Coolidge	50	68	R	R	Same	1999	William J. Clinton	37	106	R	R	Same
1925	Calvin Coolidge	50	69	R	R	Same	2001	George W. Bush	12	107	R	R	Same

1927	Calvin Coolidge	50	70	R	R	Same	2003	George W. Bush	12	108	R	R	Same
1929	Herbert Hoover	37	71	R	R	Same	2005	George W. Bush	12	109	R	R	Same
1931	Herbert Hoover	37	72	D	R	Not Same	2007	George W. Bush	12	110	D	D	Same
1933	Franklin D. Roosevelt	635	73	D	D	Same	2009	Barack Obama	10	111	D	D	Same
1935	Franklin D. Roosevelt	635	74	D	D	Same	2011	Barack Obama	10	112	R	D	Not Same
1937	Franklin D. Roosevelt	635	75	D	D	Same	2013	Barack Obama	10	113	R	D	Not Same
1939	Franklin D. Roosevelt	635	76	D	D	Same							
1941	Franklin D. Roosevelt	635	77	D	D	Same							
1943	Franklin D. Roosevelt	635	78	D	D	Same							

Sources: http://clerk.house.gov; http://www.senate.gov/