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ABSTRACT

Growth in the Shadows: Effect of the Shadow Economy on U.S. Economic Growth over More Than a Century

This paper provides a long-term view by studying the effect of the underground or shadow economy on economic growth in the Unites States over the period 1870 to 2014. Shadow activities might spur or retard economic growth depending on their interactions with the formal sector and impacts on the provision of public goods. Nesting the analysis in a standard neo-classical growth model, we use a relatively new time-series technique to estimate the short-run dynamics and long-run relationship between economic growth and its determinants. Results suggest that prior to WWII the shadow economy had a negative effect on economic growth; however, post-WWII the shadow economy was beneficial for growth. This ambiguity regarding the overall growth impact of the shadow economy is consistent with underlying theoretical arguments.

JEL Classification: E26, O43, O51, K42

Keywords: economic growth, shadow economy, United States, time series

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1. Introduction

Interest in the drivers of economic growth has drawn economists' and policymakers' attention for many years, with numerous studies varying in data, scope and detail (see Barro and Sala-i-Martin (2003), Fichtenbaum (1989), Mankiw et al. (1992), Temple (1999)). The body of related research on U.S. economic growth, however, is relatively small (see, for examples, Panizza (2002), Wiseman (2017)). On the other hand, the causes and effects of the shadow economy have also garnered a fair bit of attention (see Schneider and Enste (2000)), albeit, due to underlying measurement issues, the empirical research in this regard is relatively recent.

This paper examines the nexus between the shadow economy and economic growth with an application to the United States over more than a century. The informal sector is a non-negligible part of overall U.S. economic activity and this sector has persisted over time. Thus, we are intersecting the literature on the underground economy with that on economic growth. Does greater prevalence of the shadow economy retard or promote U.S. economic growth?

It is not clear a priori whether the shadow economy can promote or harm economic growth. On the one hand, lower tax collections due to leakages to the informal or underground sector would reduce direct and indirect government spending, while also adversely affecting the incentives of tax paying firms. This would cause economic growth to go down with an expansion in the informal sector. On the other hand, the informal sector might provide greater competition and efficiency to the formal sector, possibly resulting in greater economic growth. The presence of the shadow economy, for instance, enables formal sector firms to outsource services cheaply or evade stringent regulations. Not only are these theoretically opposite effects ambiguous, the resulting empirical evidence regarding the effects of the informal sector on economic growth is also ambiguous (see Schneider and Enste (2000)). Our formal analysis will shed light on this effect for the United States.

The main contributions of this work include:

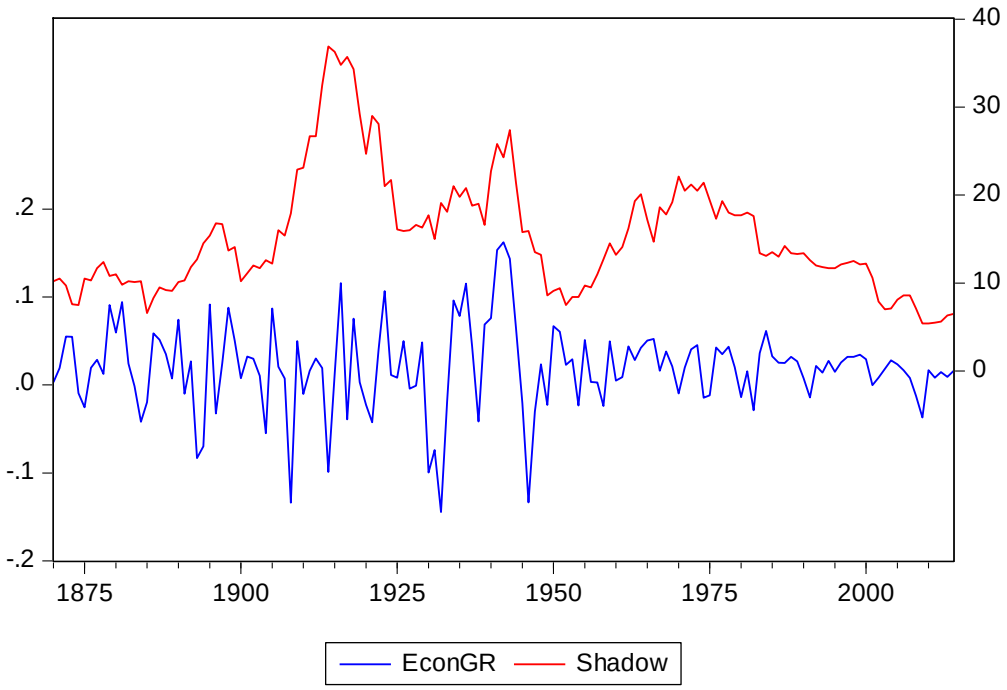
- Examination of the nexus between the shadow economy and economic growth.
- Determinants of U.S. economic growth over more than a century.
- Both short-run and long-run economic growth.
- Consideration of economic and military shocks on economic growth.

Figure 1 illustrates the time-series of both U.S. economic growth (*EconGR*) and the shadow economy (*Shadow*).[1] The first point to note from the figure is that the shadow economy in the United States has been significant over time, although it has been variable. The size of the shadow economy increased significantly after the turn of the century and then decreased during the so-called "Roaring Twenties". Interestingly, the increase in size of the shadow economy during WWII was likely due to the development of black markets to supply consumer goods while most formal production was redirected to support the war effort. Further, wartime demands related to expedited production and delivery of certain goods might have encouraged outsourcing from the informal sector. Then the shadow economy increased from the early 1950's to 1975

[1] See Table 2 for details about how these variables are measured.

most likely as a result of the high marginal income tax rates and inflation during this period. Finally, the shadow economy has been experiencing a downward trend since approximately 1975 consistent with the deregulation of major industries (e.g. airlines, telecommunication and financial) and the overall strength of the formal economy. Alternatively, economic growth is relatively volatile prior to the 1950's while stabilizing during the post-1950 period dubbed "The Great Moderation." During the sample under consideration, the three negative shocks to economic growth occur during WWI (1914-1918), the Great Depression (1929-1939), and WWII (1939-1945). Moreover, the shadow economy appears to be pro-cyclical over most of this time period.

Figure 1: Economic Growth vs U.S. Shadow Economy



Note: Details of the underlying data and the variables used are in Table 2.

Broadly speaking, this research contributes to the literature on economic growth (especially U.S. economic growth)[2] and the effects of the informal economy. Next, we proceed with the formal analysis that examines the validity and robustness of the relation between the shadow economy and U.S. economic growth observed in Figure 1.

In terms of the broader literature, the present work is systematic and the first analysis of the size of the shadow economy on US growth over a long time period. The remainder of this paper is organized as follows: In chapter 2 we undertake some theoretical reasoning about the interaction

[2] There are, however, studies on other aspects of U.S. economic growth (see Bjørnskov (2016), Goel et al. (2008), Jerzmanowski (2017), Panizza (2002), Wiseman (2017)).

between the official and unofficial economy. In chapter 3 we deal with the specific literature and develop our model. In chapter 4 we describe the data, provide the estimation results and write down the estimation equation. Chapter 5 provides the empirical results and in chapter 6 some concluding remarks are drawn.

2. Theoretical reasoning about the interaction between the official and unofficial economies

Obviously there are many interactions between the official (registered) and unofficial (shadow) economies in a country[3], here the U.S. Hence, a strict separation of these two parts of the economy is not possible.[4] Therefore, it is not surprising that there is a continuous interaction between the official and unofficial economies. Schneider (2005, 2010) emphasizes that the official part of the economy could never work efficiently if it were totally separated (disentangled) from the unofficial part. A study carried out by the OECD highlights these concerns further, that the shadow economy permanently competes with the official economy; on the other hand, Lubell (1991) and Schneider (2005) state that the formal and informal economies also complement each other. Other studies (Besozzi (2001) and Schneider (2005)) show that a certain influence of the shadow economy on the efficient functioning and development of the official economy cannot be denied.

In principle, these interactions stem from three main topics that are influenced by the shadow economy, namely taxation, general locations and biased effects of economic policies. The interactions and their effects originating from these three main sources are shown in Table 1.

[3] Some parts and arguments are taken from Schneider and Hametner (2014, pp. 297-298).
[4] Compare Besozzi (2001), Lubell (1991), Schneider (2005, 2010), Schneider and Hametner (2014) and Williams and Schneider (2016).

Table 1: Interactions between the shadow and the official economy

The shadow economy influences ↓	**Through**	**Effects on official economy and overall economic performance**[#]
Tax system →	Tax evasion →	Redistribution policies to finance qualitative and quantitative improvements of public goods are impaired, thus economic growth may be negatively affected (Schneider (2005))
↘	Additional tax revenues →	If the shadow economy activity is complementary to the official economy, extra income is generated via the shadow economy which is then (at least partly) spent in the official economy for goods and services (Schneider (2005))
Allocations →	Stronger competition and stimulation of markets ↗	More efficient use of scarce resources (Schneider (2005))
	↗	Incentives for firms and individuals, stimulation of creativity and innovation
	→	Enlargement of market supply through additional good and services
	→	Cost advantages of producers acting from the shadow economy may lead to ruinous competition
	↘	Problems in information flows for producers and consumers due to reduction in transparency and lack of structure in unofficial sector
Policy decisions →	Bias in officially published data →	Stabilizing, re-distributional and fiscal policies may fail desired effects

Source: Schneider and Hametner (2014, p. 298).

[#] For a more detailed discussion on outcomes of economic policy based on biased data compare McGee and Feige (1989), Fleming, Roman, and Farrell (2000), Schneider (2005, 2010), Schneider and Enste (2002).

Various studies, for example Schneider (2005, 2006) and Williams and Schneider (2016) demonstrate that the interaction between the official and the shadow economy takes place but still their results are discussed controversially, especially whether the positive effects dominate over negative ones or vice versa. As these effects always depend on the concrete size of the shadow economy, the intensity of the interaction between the formal and informal sectors and the specific economic situation of a country, an answer can only be given after a careful

empirical analysis is undertaken for concrete countries which we will do in this paper for the U.S.

In order to study the effects of the underground economy on the official one, the underground economy or shadow economy has been integrated into macroeconomic models. This ends in an extended macro model of the business cycle, as well as tax and monetary policy linkages with the shadow economy. As a result, it becomes clear that these effects should be taken into account for tax and regulatory policies. The presence of a shadow economy tends to overstate the inflationary effect of a fiscal or monetary stimulus and tends to understate the respective effects of unemployment. When the growth of the shadow economy and the official economy are positively related (which is likely to be the case when entry costs into the shadow economy are low due to the probability of enforcement), an expenditure fiscal policy has a positive stimulus for both the formal and the informal economies. It has also been found that the US productivity slowdown over the period 1970-1998 was vastly overstated, as the underreporting of income (or shadow economy activities) due to the more rapid growth of the U.S. shadow economy during this period was disregarded.[5] The underground economy is a beneficiary in so far as it responds to the economic environmental demands for urban services and small skill manufacturing. These sectors provide the economy with dynamic and entrepreneurial spirit and can strengthen competition, increase efficiency, and put effective limits on government activities. These sectors contribute to the creation of markets, increase financial resources and transform the legal, social and economic institutions necessary for accumulation. Moreover, a substantial part (up to 70% of the earnings gained in the shadow economy) is quickly spent in the official sector and thus boosts the demand in the official economy. These expenditures tend to raise consumer expenditures as well as (mostly indirect) tax revenues. Theoretically the effect of the shadow economy on the official one and vice versa is open. It's really an empirical question which we will handle in this paper.

3. Literature and the model

This research can be seen as addressing the effects of the shadow economy, rather than its causes. There has been quite a bit of research on the drivers of economic growth with scholars considering different time periods and different sets of explanatory variables (see Barro and Sala-i-Martin (2003), Levine and Renelt (1992), Mankiw et al. (1992), Temple (1999) for some reviews of the related literature). On the other hand, the literature on the shadow economy, encompassing its causes and effects, is relatively recent, with many significant contributions flowing from the work of Schneider and associates. Within this spectrum, there is a shorter body of research examining the impact of the shadow economy on economic growth. The earlier work in this regard is nicely summarized in Schneider and Enste (2000), and we borrow some from their work (also see Schneider (2012)).

[5] Early forerunners of this question about the effect of the official economy on the shadow economy and vice versa have been Aigner, Schneider and Ghosh (1988) and Pommerehne and Schneider (1985).

In another take, it is argued that tax revenues go up as the shadow sector declines. These enhanced revenues in turn improve the quantity and quality of public goods, which would fuel economic growth. Alternately, in the presence of congestible public goods, both the formal and informal sectors compete for public services, with the informal sector free riding on such services. This results in inefficient allocation and/or use of public goods, leading to lower growth. This negative relation between the shadow economy and economic growth is noted by Loayza (1996) for Latin America.

On the other hand, the shadow economy and economic growth can have a positive relation when informal markets improve overall competitiveness and provide avenues for shadow entrepreneurs to escape stringent government regulations in the informal sector (see, e.g., Williams (2006)). This self-selection by entrepreneurs can ultimately increase economic growth. Furthermore, the shadow economy absorbs the excess demand and supply of the formal economy. For instance, over the short run during economic downturns the shadow economy employs unemployed workers and provides cheaper products and services. Over the long run, the shadow economy has the ability to alter institutions that are necessary for factor accumulation (Asea (1996)).

Thus the overall effect of the shadow economy on economic growth is ambiguous (see Schneider and Enste (2000)) and the present work will shed light on this for the United States over a considerable period of time.

When one talks about a clandestine activity like the shadow economy, one must dwell some on underlying measurement issues (Schneider and Buehn (2016)). Two studies drawing on this aspect for the United States include Fichtenbaum (1989) and Pommerehne and Schneider (1985). Fichtenbaum (1989) argues that the income underreporting due to the growth of the shadow economy led to overstating the U.S. productivity slowdown over 1970-1989.

Based on these considerations, the general form of the estimated growth equation is the following

$$EconGR_t = \text{f}(Shadow_t, INV_t, EDU_t, \text{Shocks}_k) \qquad \ldots(1)$$

$t = 1870, \ldots, 2014$

$k = Depression, WWI, WWII$

The dependent variable is the annual rate of per capita real GDP growth (*EconGR*). The main explanatory variable is the prevalence of the shadow economy (*Shadow*). As the above discussion makes clear, the effect of shadow on economic growth could be positive or negative. The formal analysis below will reveal which effect will prevail over time.

Consistent with most growth models, we control for investment (*INV*) and labor quality (*EDU*) in driving economic growth.[6] As noted above, while numerous influences on economic growth

[6] See Kalaitzidakis et al. (2001) for alternate measures of human capital in terms of their relation with economic growth. The authors note that possible nonlinear effects of human capital measures and economic growth do not extend across all human capital measures.

have been considered, investment and labor quality are among the ones consistently used (see Levine and Renelt (1992)).

Then we control for economic and military shocks that might have significantly affected economic growth over this long period of time. With regard to economic shocks, we consider a dummy variable identifying the years of the Great Depression (*Depression*). The Great Depression caused unprecedented macroeconomic upheavals, plus during that period (and prior to that) the U.S. economy did not have an autonomous body like the Federal Reserve to drive macroeconomic policy. For military shocks, we consider the periods of the two world wars. The two world wars can be considered macroeconomic shocks that required rapid and sometimes ad hoc redirection of government policies, all of which likely affected economic growth. Also, many developments during the war period were beyond the control of U.S. government.

Besides the long period under consideration, the inclusion of economic and military shocks may be considered as contributions of this work. With regard to the related literature, Fatas (2000) has focused on the effect of persistent demand fluctuations and growth rates of GDP, while Jerzmanowski (2017) examines the effects of banking deregulation on U.S. economic growth. Taking banking deregulation to be an exogenous measure of financial development, the author finds deregulation to have a beneficial effect on growth. Next, we turn to a description of the data and the estimation.

4. Data and estimation

4.1 Data

The long time series on the prevalence of the shadow economy in the United States comes from Géidigh et al. (2016). The authors provide estimates of the US shadow economy for 1870-2015 using the currency demand method (the underlying idea being that shadow transactions would increase the demand for cash to keep them out of the scrutiny of tax authorities). The adequate measurement of a clandestine activity like the shadow economy has drawn critical commentary (see Schneider and Buehn (2016), Tanzi (1999)) and there are other approaches, notably the MIMIC method. However, we use the currency demand method in this study. This measure seems appropriate, plus there is unavailability of alternate measures for the United States over the long time period considered. In our sample, the average prevalence of the shadow economy over the period 1870 to 2014 was 15.30 % of GDP (also see Figure 1).

Annual data dating back to 1870 to 2014 were collected from a variety of sources—see Table 2 for details. The main variable of interest in our model is economic growth per capita (*EconGR*) measured as the change in the log of real GDP per capita.

Examining another influence on economic growth, Panizza (2002) considered the relation between income inequality and economic growth across U.S. states and found the relation to be not robust.

To explain *EconGR*, we follow the standard neo-classical growth model of Mankiw et al. (1992) and include investment in physical capital (*INV*) and human capital investment (*EDU*) measured by the number of high school graduates per capita (see also Levine and Renelt (1992)). In contrast to Mankiw et al. (1992), we augment the neo-classical growth model to include a measure for the shadow economy, which is another important factor that potentially influences economic growth and has been largely neglected in the growth literature. The size of the shadow economy is measured as a percent of GDP (*Shadow*). As mentioned above, the literature has analyzed numerous influences on economic growth (see Barro and Sala-i-Martin (2003), Levine and Renelt (1992), Mankiw et al. (1992)). We anchor our analysis in the two consistently used determinants - investment and labor quality - and then focus on *Shadow* as the key variable of interest. This setup is analyzed in the context of economic and military shocks.

4.2 Estimation

To begin the analysis, given the long time period under consideration, we examine the stationarity properties of each variable using the Augmented Dickey-Fuller test, which tests the null hypothesis of a unit root. Table 3 reports results for the unit root tests. According to the results, both *EDU* and *Shadow* contain a unit root, but their first difference is stationary; therefore *EDU* and *Shadow* are integrated of order one (i.e., I(1)).[7] Alternatively, *EconGR* and *INV* are stationary in levels and therefore integrated of order zero (i.e., I(0)). Moreover, to ensure that structural breaks over the long time-series do not influence the test results, we report a modified Augmented Dickey-Fuller test that endogenously determines structural breaks. Although the results coincide with the traditional Augmented Dickey-Fuller test, three out of the four tests reveal an endogenous break during World War II.

Although the variables are of different orders of integration, it is still possible that there exists a long-run equilibrium relationship. To estimate a levels relationship we rely on a relatively new methodology from Pesaran and Shin (1998) and Pesaran et al. (2001) based on an autoregressive distributed lag (ARDL) approach. Unlike traditional cointegration tests, such as Engle-Granger (1987) and Johansen and Juselius (1990) which require that the variables be integrated of the same order, the Bounds testing approach is able to test for the existence of a levels relationship among I(0) and I(1) variables. This is especially appealing given the low power of unit root tests. Also, this estimation technique can be used whether the variables are cointegrated or not.

The Bounds testing approach for testing for co-integration begins by estimating the following error correction model (see, e.g., Eq. (8) of Pesaran et al. (2001, p. 293)):

$$\Delta EconGR_t = \alpha_0 + \sum_{i=1}^{p_1} \gamma_i \Delta EconGR_{t-i} + \sum_{i=0}^{p_2} \lambda_i \Delta INV_{t-i} + \sum_{i=0}^{p_3} \delta_i \Delta EDU_{t-i} + \sum_{i=0}^{p_4} \theta_i \Delta Shadow_{t-i} + \pi_1 EconGR_{t-1} + \pi_2 INV_{t-1} + \pi_3 EDU_{t-1} + \pi_4 Shadow_{t-1} + Shocks_t^j + \varepsilon_t \quad \ldots(2)$$

[7] We also alternately measured education via bachelor's degrees conferred and the main results were similar. Details are available upon request.

Where α_0 is the drift component; $Shocks_t^j$ include dummy variables for *j* events (WWI and the Great Depression); and ε_t are the serially uncorrelated errors. The lag length for each variable of the ARDL (p_1, p_2, p_3, p_4) is chosen by the Schwartz Information Criterion (SIC), assuming a maximum lag length of 8 lags. The lags must be long enough to render ε_t serially uncorrelated and not too long as to lead to an over parameterization. To check for serial correlation we report the Q-statistic at 36 lags under the null of no serial correlation.

The Bounds test is based on the partial F-test under the null of no co-integration ($\pi_1 = \pi_2 = \pi_3 = \pi_4 = 0$) against the alternative of cointegration ($\pi_1 \neq 0, \pi_2 \neq 0, \pi_3 \neq 0, \pi_4 \neq 0$). However, according to Pesaran et al. (2001), the distribution of the F-statistic is non-standard regardless of whether the variables are I(0) or I(1). Therefore, Pesaran et al. (2001) develop critical values for the lower bound, assuming all variables are I(0), and for the upper bound, assuming all variables are I(1). If the F-statistic falls below the lower bound, then we fail to reject the null hypothesis and if the F-statistic exceeds the upper bound then we reject the null hypothesis. If the F-statistic falls within the upper and lower bound then the test is inconclusive.

Given evidence of co-integration, the methodology proceeds to estimate the following ARDL error correction model

$$\Delta EconGR_t = \alpha_0 + \sum_{i=1}^{p_1} \gamma_i \Delta EconGR_{t-i} + \sum_{i=0}^{p_2} \lambda_i \Delta INV_{t-i} + \sum_{i=0}^{p_3} \delta_i \Delta EDU_{t-i} + \sum_{i=0}^{p_4} \theta_i \Delta Shadow_{t-i} + \phi_1 ECT_{t-1} + Shocks_t^j + \varepsilon_t \quad \ldots (3)$$

Where ECT_{t-1} is the error correction term which measures deviations from the long-run equilibrium and ϕ_1 captures the speed of adjustment to long-run equilibrium. The first differenced variables and their corresponding coefficients give the short-run dynamic responses. Therefore, the error correction model includes the short-run dynamics and the adjustment to the long-run equilibrium. The results section follows.

5. Results

The unit root test reveals a significant break in the data during World War II, therefore, prior to estimation, we split the sample into pre- and post-WWII (the pre-WWII sample has a dummy variable for the years of WWI and another one for the Great Depression). We first test for co-integration using the Bounds testing procedure outlined above based on equation (2). The F-statistic for each sub-sample is reported in Table 4 and for both samples the F-statistic exceeds the upper bound, indicating a rejection of the null hypothesis of no co-integration (Pesaran et al. (2001)).[8]

[8] It is worth mentioning that according to the Bounds testing results, *Shadow* is a 'long-run forcing variable' in both samples.

Given evidence of co-integration, we proceed by estimating the ARDL error correction model described by equation (3) for each sample. The optimal lag lengths chosen by the SIC for the ARDL(p_1, p_2, p_3, p_4) is ARDL(1, 0, 2, 0) for the pre-WWII sub-sample and is ARDL(6, 0, 0, 0) for the post-WWII sub-sample. To ensure the residuals are free from serial correlation, we report the Q-statistics at 36 lags under the null of no serial correlation. The high p-value across both samples indicates failure to reject the null of no serial correlation. In addition, we report the Jarque-Bera test for normality (under the null of normality) and the Breusch-Pagan-Godfrey test for heteroscedasticity (under the null of homoscedasticity). According to these tests, the errors are normally distributed and free from heteroscedasticity. See the bottom of Table 5 for the results of the diagnostic tests. Furthermore, to test the stability of the parameters in each model we follow the advice by Pesaran and Pesaran (1997) and conduct the cumulative sum of the recursive residuals (CUSUM) and cumulative sum of the squared recursive residuals (CUSUMSQ) tests (developed by Brown et al. (1975)) to test for parameter stability in the two samples. The test results indicate parameter instability when the cumulative sum falls outside the 5% critical lines. Panel A of Figure 2 shows that both the CUSUM and CUSUMSQ test agree that the parameters are stable for the Pre-WWII sample. Panel B of Figure 2 shows conflicting results regarding parameter stability for the post-WWII sample. The CUSUM test suggests parameter stability whereas the CUSUMSQ test shows signs of parameter instability. These results should be interpreted with caution.

Table 5 provides results of the error correction model (Panel A) and the long-run co-integration estimates (Panel B). Focusing on the short-run results, in the pre-WWII sample, economic growth responds positively to capital investment and negatively to the shadow economy, whereas in the post-WWII sample economic growth responds only to capital investment. Turning to the response of economic growth to deviations from long-run equilibrium, economic growth responds faster in the post-WWII period compared to the pre-WWII period. Roughly speaking, adjustment to long-run equilibrium takes approximately one year in the pre-WWII sample and a half a year in the post-WWII sample.[9] This is consistent with The Great Moderation idea. The effect of human capital investment is insignificant across both samples.[10]

Panel B of Table 5 reports estimates for the long-run parameters. Here too are some interesting differences. First, capital investment is insignificant in the pre-WWII sample and positive and significant in the post-WWII sample. In fact, in the post-WWII sample, the coefficient on *INV* (0.34) is similar to what is expected for capital's share of income (see, e.g., Mankiw et al. (1992)). The elasticity with respect to economic growth is 3% for every 1% increase in capital investment. Interestingly, the effect of the shadow economy on economic growth has a remarkably different effect across the two periods. For instance, the shadow economy negatively affects economic growth before WWII and positively affects economic growth after WWII. In terms of elasticity, a 1% increase in the shadow economy decreases economic growth by 1.5%

[9] Approximate speed of adjustment is measured as the reciprocal of the absolute value of the coefficient on the error correction term (see, e.g., Payne (2012))

[10] This can be likely due to use to various dimensions of human capital (see Goel and Ram (1994) and Levine and Renelt (1992)).

before WWII and increases economic growth by 0.80% after WWII.[11] It could be the case that, as argued above, the underground sector adversely affected provision of public goods before WWII, but the reverse was true after WWII. Recall that the post WWII period was also associated with large scale public investments for reconstruction, including several new public works programs (e.g., the Interstate Highway System). These likely increased opportunities in both the formal and the informal sectors spurring economic growth. Furthermore, the move toward a service sector economy facilitated by the advent of the internet opened up avenues for shadow ventures that helped facilitate growth (see for example, Gollop et al. (1987)).

6. Concluding remarks

This paper examines the impact of the shadow economy on U.S. economic growth over nearly a century and a half. While many studies exist in the literature on the determinants of economic growth, research on the impact of the shadow economy on economic growth is quite limited, especially for the United States. Over time, the underground sector has persisted in the United States, although its prevalence has varied (see Figure 1 and Table 2). There exists little formal research on the impact of the underground economy on U.S. economic growth over time.

Theoretically, the effects of the underground sector can be positive or negative. The shadow economy would retard economic growth (the "sanding" argument) when low tax collections due to the informal sector reduce externalities. On the other hand, shadow economy will spur economic growth (the "greasing" argument) when synergies with the formal sector improve productivity and growth.

Nesting the analysis in a standard neo-classical growth model, we use a relatively new time-series technique due to Pesaran et al. (2001) to formally estimate the short-run dynamics and long-run relationship between economic growth and its determinants. Consistent with the literature (Goel and Ram (1994), Levine and Renelt (1992)), we find support for the positive growth effects of investment. Regarding the main focus on the shadow economy-growth nexus, results suggest that prior to WWII the shadow economy had a negative effect on economic growth, however, post-WWII the shadow economy was beneficial for growth. The insignificances of the Great Depression and WWI (in the pre-WWII sample) suggests that both economic and military shocks did not have an appreciable impact during that time period. Thus, the shadow economy "sanded" economic growth before WWII, but "greased" growth in the post war period.[12]. This ambiguity regarding the overall growth impact of the shadow economy is consistent with underlying theoretical arguments. This finding poses some challenges for policymakers thinking of measures to control the shadow sector. One implication is that production in the shadow economy is only worthwhile (useful) when you can shift it into the official economy (via synergies), especially, given the positive sign after World War II. These

[11] We also included a dummy variable for the Great Recession (2007-2009) and the results were robust. These results are available by request.

[12] The issue of positive and negative growth effects of corruption has been well recognized in the literature (see Méon and Sekkat (2005)).

synergies between the two sectors do not seem to have been formally recognized. This redeeming influence of the shadow economy on growth seems novel.

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Table 2: Variable Definitions, Summary Statistics and Sources

Variable	Definition	Mean	S.D.	Min	Max
EconGR	The change in the log of real GDP per capita. Source: Johnston and Williamson (2017)	0.019343	0.048799	-0.14441	0.162188
INV	Investment-to-output ratio. Source: Jordà et al. (2017)	0.168965	0.046175	0.017287	0.24192
EDU	Fraction of population with a high school degree. Source: Goldin (2006)	0.006691	0.004725	0.000401	0.014506
Shadow	The size of the shadow economy (% of GDP). Source: Geidigh et al. (2016)	15.30138	6.788992	5.4	36.9
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.				

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

Table 3: Unit Root Tests: Augmented Dickey-Fuller

Variable	**ADF[a]**	**ADF-Break Point Test[b]**
Shadow	-1.78 [0.3887]	-2.44 [0.9169] Break Date: 1943
ΔShadow	-11.62*** [0.000]	-12.25*** [<0.01]
EDU	1.27 [0.644]	-2.95 [0.714] Break Date: 1944
ΔEDU	-3.56*** [0.008]	-5.93*** [<0.01]
INV	-2.80* [0.061]	-4.92** [0.012] Break Date: 1942
EconGR	-8.96*** [0.000]	-9.67*** [<0.01] Break Date: 1932

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.

Table 4: Cointegration Test: Bounds Testing Procedure

Pre-WWII Sample (1870-1938)	
F-statistic	14.80
(k=3)	
Post-WWII Sample (1946-2014)	
F-statistic	12.70
(k=3)	

Notes: Critical value bounds for the Bounds testing with intercept and no trend and k=3 are:

Significance	I(0) Bound	I(1) Bound
10%	2.37	3.2
5%	2.79	3.67
1%	3.65	4.66

Table 5: ARDL Error Correction Model & Long-run Coefficient Estimates

	Pre-WWII Sample (1870-1938)		**Post-WWII Sample (1946-2014)**	
Panel A: ARDL Error Correction Model				
	Coefficient	Standard Error	Coefficient	Standard Error
$\Delta EconGR_{t-1}$			0.993104***	0.179646
$\Delta EconGR_{t-2}$			0.717283***	0.141923
$\Delta EconGR_{t-3}$			0.548076***	0.116302
$\Delta EconGR_{t-4}$			0.341385***	0.106874
$\Delta EconGR_{t-5}$			0.206497**	0.090570
ΔEDU_t	0.600299	30.291867	4.445537	6.878647
ΔINV_t	1.190733***	0.245281	0.902159**	0.276165
ΔINV_{t-1}	0.849360***	0.295480		
$\Delta Shadow_t$	-0.004479	0.002609	0.002152	0.001899
$\Delta Depression$	0.018820	0.047421		
ΔWWI	0.023284	0.036235		
ECT_{t-1}	-1.099675***	0.118696	-2.232741***	0.260311
Panel B: Long-Run Coefficients				
EDU	1.236263	3.350412	0.212158	0.870489
INV	-0.163740	0.264659	0.341120***	0.076750
Shadow	-0.001896*	0.001079	0.001005***	0.000337
WWI	0.052732	0.035642		
Depression	-0.016140	0.024315		
C	0.068369	0.056169	-0.065390***	0.018501
Diagnostic tests				
Q-Stat (36)	23.80	[0.692]	23.21	[0.722]
Jarque-Bera test	1.61	[0.448]	0.15	[0.929]
Breusch-Pagan-Godfrey test	0.78	[0.634]	1.30	[0.270]

Note: ECT_{t-1} is the error correction term, which captures deviations from the long-run equilibrium; C is constant term and the other variables are defined in Table 2.