CONTEMPORARY ECONOMIC POLICY

GROWTH IN THE SHADOWS: EFFECT OF THE SHADOW ECONOMY ON U.S. ECONOMIC GROWTH OVER MORE THAN A CENTURY

RAJEEV K. GOEL, JAMES W. SAUNORIS and FRIEDRICH SCHNEIDER*

Taking a long-term look at U.S. economic growth over 1870–2014, this paper focuses on the spillovers from the shadow or the unofficial economy to growth in the official sector. 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 neoclassical 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 World War II (WWII) the shadow economy had a negative effect on economic growth; however, post-WWII the shadow economy was beneficial for growth. The sanding effect of the shadow economy in the earlier period is especially robust to alternate considerations of possible endogeneity and an alternate set of growth determinants. (*JEL* E26, O43, O51, K42)

I. 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; Jones 2016; Mankiw, Romer, and Weil 1992; Temple 1999). The body of related research on U.S. economic growth, however, is relatively small (e.g., 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.[1] Despite the United States being a developed nation, the informal sector is a

*Useful comments of two referees are appreciated. An earlier version of this paper was circulated as an IZA Discussion Paper no. 10705. The authors' names appear in alphabetical order and no seniority of authorship is implied.

Goel: Professor, Department of Economics, Illinois State University, Normal, IL, 61790-4200; Research Fellow, Kiel Institute for the World Economy, Kiel, Germany. Phone 309 438 2360, Fax 309 438 5228, E-mail rkgoel@ilstu.edu

Saunoris: Associate Professor, Department of Economics, Eastern Michigan University, Ypsilanti, MI 48197. Phone 734 487 3068, Fax 734 487 9666, E-mail jsaunori@emich.edu

Schneider: Professor, Department of Economics, Johannes Kepler University Linz, A-4040 Linz, Austria. Phone +43 732 2468 7340, Fax +43 732 2468 7340, E-mail friedrich.schneider@jku.at

1. The shadow or underground economy captures economic activity that is not captured in official accounts of GDP, although interpretations of what is captured sometimes vary. A precise and the most commonly used definition of the shadow sector is described in detail by Gyomai and van de Ven (2014). The authors provide the following classifications across various dimensions of the underground economy (Gyomai and van de Ven 2014):

(i) Underground production: Activities that are productive and legal, but deliberately concealed from public authorities.

(ii) Illegal production: Productive activities that generate goods and services forbidden by law or they are unlawful when carried out by unauthorized procedures.

(iii) Informal sector production: Productive activities conducted by incorporated enterprises in the household sector or other units that are registered and/or less than specified size in terms of employment and have some market production.

(iv) Production of households for own final use: Productive activities that result in goods or services consumed or capitalized by the households that produced them.

(v) Statistical "underground": All productive activities that should be accounted for in basic data collection programs, but are missed due to deficiencies in the statistical system.

This estimation method is applied by National Statistical Offices and is explained in detail in the Handbook for Measuring the Non-Observed Economy, OECD (2010). The authors argue that nonobserved economy estimates take place

ABBREVIATIONS

ARDL: Autoregressive Distributed Lag
GDP: Gross Domestic Product
SIC: Schwartz Information Criterion
WWI: World War I
WWII: World War II

Contemporary Economic Policy (ISSN 1465-7287)
doi:10.1111/coep.12288

nonnegligible 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 (grease) or harm (sand) 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 analyzed.
- Both short- and long-run economic growth considered.
- Consideration of economic and military shocks on economic growth.

The period of prohibition (roughly 1920–1933) also falls in the pre-World War II (WWII) period, as do other developments like World War I (WWI) and the Great Depression. It is well-known that prohibition gave rise to a form of shadow activity in terms of moonshine production of alcohol, albeit with significant variations across individual states/regions (https://en.wikipedia.org/wiki/Prohibition_in_the_United_States). This increase in underground activity would generally have had a negative impact on economic growth, although the persistence of underground operations set up during prohibition could have growth implications over time. However, there is little formal evidence on whether the increase in moonshine activity was in conjunction with other shadow activities or at the expense of (crowding out) other shadow activities. We address this aspect in Section V.D.

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.

In terms of the broader literature, the present work is systematic and the first analysis of the impact of the shadow economy on U.S. growth over a long time period. Besides contributing to the literature, the work has relevance for evaluating the long-run costs and benefits of the unofficial sector (see Schneider 2005, 2012).

The remainder of this paper is organized as follows: In Section II we undertake some theoretical reasoning about the interaction between the official and unofficial economy. In Section III we deal with the specific literature and develop our model. In Section IV we describe the data and formalize the estimation equation. Section V provides the empirical results and in the last section some concluding remarks are drawn.

II. THEORETICAL REASONING(S) ABOUT INTERACTION(S) 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 United States. 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 Organisation for Economic Co-operation and Development (OECD) highlights these concerns further, that

at various stages of the integrated production process of national accounts.

2. There are, however, studies on other aspects of U.S. economic growth (see Bjørnskov 2017; Goel, Payne, and Ram 2008; Jerzmanowski 2017; Panizza 2002; Wiseman 2017).

3. Some parts and arguments are taken from Schneider and Hametner (2014, 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[a]
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
		→ Expansion of market supply through additional goods and services
		→ Cost advantages of producers operating in 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, redistribution, and fiscal policies may fail to have desired effects

[a]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).
Source: Schneider and Hametner (2014, 298).

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 complement each other. Other studies (Besozzi 2001; Schneider 2005) show that a certain influence of the shadow economy on efficient functioning and development of the official economy cannot be denied.

The traditional view about what drives firms and individuals to operate underground is to evade taxes and regulations (see Schneider and Enste 2000). These movements in turn affect growth, both directly and indirectly. The direct effects occur via frictions in movements between the formal and informal sectors (i.e., the informal sector's inability to raise finance in the formal sector or to avail of public services such as police protection, etc.), whereas the indirect effects occur due to the impacts on tax revenues, which strain and reduce public goods over time. Furthermore, the direct and indirect effects might not necessarily have negative implications for growth—they can be positive when a developed underground sector is complementary to the formal sector. These direct and indirect effects evolve differently over time, thus, potentially having different growth implications.

Over the long term, a strong and growing shadow sector would impact economic growth via its (mainly adverse) impacts on investments. Underground firms are unable to obtain loans in the formal sector and end up paying higher interest charges in the informal sector, which increases their costs. This limits their expansion and potential synergies with the official sector, both of which would inhibit growth. Conversely, the long-term growth effects of the shadow sector could be positive when shadow operators who are initially able to bypass government market entry and/or licensing restrictions are over time able to positively contribute, either themselves (e.g., via innovation) or via effective support for the formal sector. The structural shift in the composition of the economy changed dramatically post-WWII, which likely changed the role the shadow economy served in the economy. For example, the dramatic increase in labor participation among females (see Goel and Saunoris 2017), rapid rise in the service sector, and the advent of the internet all spawned new shadow markets and opportunities that spill over to formal sector growth (Andrés and Goel 2012).

In principle, these interactions stem from three main channels 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 sources are shown in Table 1.

Various studies, for example, Schneider (2005, 2006) and Williams and Schneider (2016)

demonstrate that the interaction(s) between the official and the shadow economy takes place. However, it is not clear whether the positive effects dominate over negative ones or vice versa. These effects always depend on the specific size of the shadow economy, the intensity of the interaction(s) between the formal and informal sectors, and the specific economic situation of a country. A definitive answer can only be given after a careful empirical analysis is undertaken, which we will do in this paper for the United States.

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 leads to an extended macro model of the business cycle, as well as tax and monetary policy linkages with the shadow economy. 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), an expenditure fiscal policy has a positive stimulus for both the formal and the informal economies. It has also been found that the U.S. 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 (Fichtenbaum 1989).[5] The underground economy has a positive influence in so far as it responds to the economic demands for urban services and small-scale manufacturing. These sectors provide the economy with dynamic and entrepreneurial spirit and can strengthen competition, increase efficiency, and put effective limits on government activities. In addition, a substantial part (up to 70% of the earnings gained in the shadow economy) is quickly spent in the official sector and thus boosts demand in the official economy. These expenditures tend to raise consumer expenditures as well as (mostly indirectly) tax revenues. Thus, these linkages can have positive growth effects. Theoretically, the effect of the shadow economy on the official one and vice versa is an open question. It is really an empirical question which we will handle in this paper.

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).

III. LITERATURE AND THE MODEL

This research can be seen as addressing the effects of the shadow economy, rather than its causes (see Goel, Saunoris, and Schneider 2017). 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; Jones 2016; Levine and Renelt 1992; Mankiw, Romer, and Weil 1992; and 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 smaller 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).

The literature about the effect of the shadow economy on the official economy is quite large. In this part, we make some basic and principal arguments and quote some literature.

A. Effects of the Shadow Economy on the Official Economy

In order to study the effects of the shadow economy on the allocation of resources, several studies integrate underground economies into macroeconomic models.[6] Houston (1987) develops a theoretical model of the business cycle as well as tax and monetary policy linkages with the shadow economy. He concludes that, on the one hand, the shadow economy's effect should be taken into account in setting tax and regulatory policies, and on the other hand, the existence of a shadow economy could lead to overstatement of the inflationary effects of fiscal or monetary stimuli. In their study for Belgium, Adam and Ginsburgh (1985) find a positive relationship between the growth of the shadow economy and the official sector.

Another hypothesis is that a substantial reduction of the shadow economy leads to a significant increase in tax revenues and therefore to a greater quantity and quality of public goods and services, which ultimately can stimulate economic growth. Some authors found evidence for

6. For Austria this was done by Neck, Hofreither, and Schneider (1989) and Schneider, Hofreither, and Neck (1989). For further discussion, see Giles (1999) and Quirk (1996).

this hypothesis. Loayza (1996) concludes that in economies where (1) the statutory tax burden is larger than optimal, and where (2) enforcement of compliance is too weak, the increase in the relative size of the informal economy generates a reduction in economic growth. The reason for this is the negative correlation between the informal sector and public infrastructure indices. This negative impact of informal sector activities on economic growth is not broadly accepted. For example, the key feature of the model has been criticized. The model is based on the assumption that the production technology depends on tax-financed public services which are subject to congestion; that is contrary to the general definition of public goods, which are not subject to congestion. In addition, the informal sector does not pay taxes but must pay penalties which are not used to finance public services. The negative correlation between the size of the informal sector and economic growth is therefore not surprising. Asea (1996) gives a more detailed criticism of the Loayza model. Depending on the prevailing view of the informal sector, one might also come to the opposite conclusion. In the neoclassical view, the underground economy, responding to the economic environment's demand for urban services and small-scale manufacturing, adds to the economy a dynamic and entrepreneurial spirit and can lead to more competition, higher efficiency, and limits on government activities. The informal sector may also contribute "to the creation of markets, increase financial resources, enhance entrepreneurship, and transform the legal, social, and economic institutions necessary for accumulation" (Asea 1996, 166). The voluntary self-selection between the formal and informal sectors may provide a higher potential for economic growth and, hence, a positive correlation between the informal sector and economic growth.

The effects of the shadow economy on economic growth therefore remain ambiguous. The empirical evidence on these opposite hypotheses is also not clear. Since many Latin American countries had or still have excessive regulations and weak government institutions, Loayza (1996) finds evidence for the implications of his growth model in the early 1990s in these countries. An increase in the size of the shadow economy negatively affects growth. But the positive side effects of shadow economy must be considered, too. Empirical findings by Schneider (1998) show that over 66% of earnings in the shadow economy are immediately spent in the official sector, with positive effects for economic growth and for indirect tax revenues. Bhattacharyya (1993, 1999) finds evidence for the United Kingdom (1960–1984) that the hidden economy has a positive effect on consumer expenditures of nondurable goods and services, and an even stronger positive effect on durable goods and services. More recently, Saunoris (2018) considers a two-sector model of the economy and finds that the shadow economy emits a positive externality onto the official sector, and productive factors in the shadow economy are more productive relative to the official sector. A close interaction between official and unofficial economies is also emphasized in Duarte (2017), Giles (1999), and Tanzi (1999).

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 an inefficient allocation and/or use of public goods, leading to lower growth.

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 (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:

$$EconGR_t = f\left(Shadow_t, INV_t, EDU_t, Shocks_t^k\right) \quad (1)$$

$$t = 1870, \ldots, 2014.$$

$$k = Depression,\ WWI,\ WWII.$$

The dependent variable is the annual rate of per capita real GDP growth (*EconGR*).[7] 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.[8] As noted above, while numerous influences on economic growth 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 prior to that period the U.S. economy did not for the most part 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 gross domestic product (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.

IV. DATA AND ESTIMATION

A. Data

The long time series on the prevalence of the shadow economy in the United States comes from Géidigh, Schneider, and Blum (2016). The authors provide estimates of the U.S. 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 Multiple Indicators Multiple Causes method. However, we use the currency demand method in this study. This measure seems appropriate, plus alternate measures are unavailable for the United States over the long time period considered. In our sample, the average prevalence of the shadow economy over the period 1870–2014 was 15.30% of GDP. This is shown in Figure 1.

Figure 1 shows the time series of both U.S. economic growth (*EconGR*) and the shadow economy (*Shadow*).[9] 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

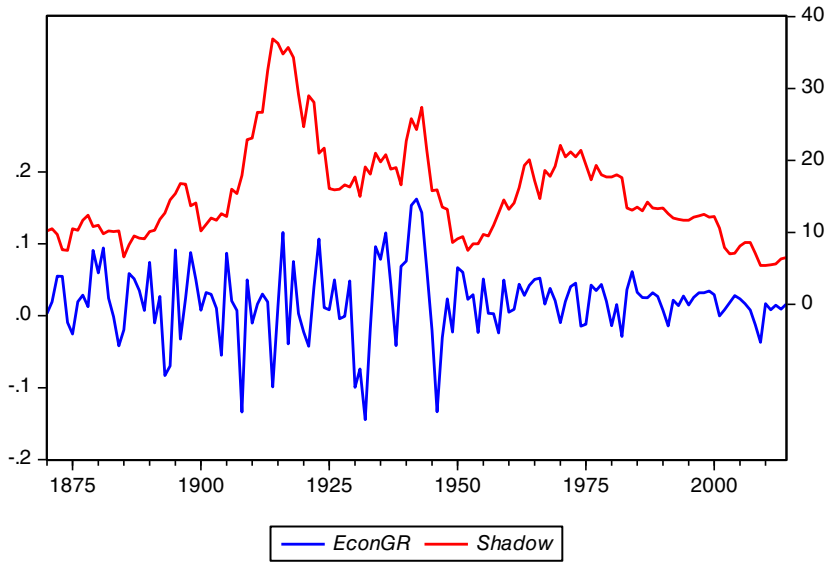
7. The underlying GDP data are based on economic activity in the formal sector.

8. 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.

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.

9. See Table 2 for details about how these variables are measured.

FIGURE 1
Economic Growth Versus U.S. Shadow Economy



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

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 1950s to 1975, 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), development of the financial sector, and the overall strength of the formal economy. Alternatively, economic growth is relatively volatile prior to the 1950s 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 procyclical over most of this time period.

Estimation Procedure Used in the Currency Demand Method. Since the currency demand method for calculating the spread of the shadow economy is a key element of this study, we describe this approach at some length. The following discussion draws on Géidigh, Schneider, and Blum (2016).[10]

Individuals and firms operating underground may be reluctant to admit their involvement in underground activities, as their supposed untraceable transactions leave a stamp on the monetary aggregates of the country. This indirect method of estimating the size of the underground sector is called the Currency Demand Approach. The main assumption of this approach is that cash, given its lack of a footprint, is the fuel in the engine of the underground economy. For instance, Isachsen and Strøm (1985) find that over 80% of shadow transactions take place in cash (also see footnote 1).

For the purpose of ascertaining the size of the shadow economy, if we could isolate the amount of cash used for illicit activities, we could infer the size of the informal sector. This approach relies on an examination of the ratio between M0 (currency in circulation) and M1 (or M2), currency in circulation and transaction deposits at depository institutions (M1 + "near money"). An increase in shadow economic activity would imply that individuals are holding more cash to pay for this increase in activity. Consequently,

10. For additional details, see Feld and Schneider (2010), Schneider and Williams (2013), and Williams and Schneider (2016).

M1 falls and M0 increases. However, there are other factors which could cause an increase in the money in circulation: central banks printing more money, falling interest rates might disincentivize individuals from lodging money in their bank accounts, etc. Therefore, these factors must be taken into account when estimating the demand for currency.

To estimate this "excess" demand for cash, an econometrically estimated demand for currency equation has evolved over time. This is known as the currency demand approach which was pioneered by Cagan (1958), subsequently by Gutmann (1977), and by Tanzi (1983). The currency demand approach, however, is not without drawbacks, as noted by Ahumada, Alvaredo, and Canavese (2006). Yet, given its wide applicability and its unique availability over more than a century, this approach proves appropriate for this study.

The dependent variable in this method can be taken as either the ratio of currency to demand deposits or the ratio of currency to M2. After the Great Depression in the United States, banks paid only a negligible interest on demand deposits (Tanzi 1980). So individuals may not have held as much money in demand deposits as the opportunity cost was low. During this period of declining spending, time deposits may have replaced demand deposits as the interest payable was higher. This would lead to a natural decrease in M1 which could not be attributed to the shadow economy. The preferred dependent variable of Schneider and also of Kirchgaessner is M0/M1, or alternatively, currency in circulation outside the banking sector, normalized by the GDP deflator. The following section sets out the explanatory variables used in the econometric equations and a brief description justifying their inclusion, citing works where they have been employed previously, and hypothesizing their relationship with the currency ratio.

Variables Used in the Currency Demand Approach for Calculating the Shadow Economy. As elaborated in Géidigh, Schneider, and Blum (2016), there are key variables used to explain the demand for cash, and thereby, the spread of the shadow economy. These include: (1) tax burden; (2) real GDP; (3) interest rate; (4) unemployment rate; (5) self-employment rate; (6) crime; (7) wages and salaries in national income; (8) social welfare spending; and (9) civic or public employment. The hypothesized relations posit that the demand for currency would decline with higher real GDP and higher interest rates, while it would increase with an increase in the other seven factors. We provide some discussion of these influences, with further details provided by Géidigh, Schneider, and Blum (2016).

(1) Tax burden: One of the key assumptions underpinning the currency demand approach to model the shadow economy is that taxes are the main driver of underground activity as individuals move underground to save taxes. Many empirical studies (Bitzenis, Vlachos, and Schneider 2016; Fleming, Roman, and Farrell 2000; Hassan and Schneider 2016; Schneider 1986, 1994a, 1994b, 2005; Schneider and Enste 2000; Tanzi 1983) have confirmed the statistically significant, positive relationship between tax burden and the underground economy. Loayza (1996) concludes from his examination of a panel of Latin American countries that informal economies arise when governments impose excessive taxes and regulations. Taxes are of interest, too, because they influence the labor-leisure trade-off and can stimulate participation in the informal economy. The intuition is that an increase in taxes reduces net (after tax) income and as such it may be more lucrative for individuals to operate in the shadow economy.

(2) Real GDP: The logic is that a growing economy increases opportunities in the formal sector, making the informal sector relatively less attractive.

(3) Interest rate: Interest rates have long been used by policymakers to influence the level of investment and spending in an economy, especially during the Gold Standard in attempts to control capital flows. A high (low) interest rate on deposit accounts increases (decreases) the opportunity cost of holding currency. Higher interest rates also make it costly to set up or subcontract shadow activities.

(4) Unemployment rate: During periods of high unemployment, the shadow economy provides ease of entry.

(5) Self-employment rate: Self-employed individuals are often directly faced with bureaucracy and legislation when setting up a business. Schneider and Enste (2002) and Hassan and Schneider (2016) cite bureaucratic red tape as a driver of underground activity (as licensing requirements are bypassed in underground activities).

(6) Crime: Since a large component of the shadow economy comprises illegal activities (e.g., smuggling), and illegal transactions escape scrutiny when they are mostly dealt in cash.

(7–9) Wages and salaries in national income, social welfare spending, and civic (public) employment: These aspects of greater government involvement would again increase the demand for cash (e.g., via direct or indirect [subcontracting] opportunities in the underground sector).

The above discussion shows the complex ways in which a clandestine activity like the shadow economy can be indirectly estimated under the currency demand method. For the present study, annual data from 1870 to 2014 were collected from a variety of sources—see Table 2 for details. The shadow economy data, based on the currency demand method of estimation, is from Géidigh, Schneider, and Blum (2016). While there are other estimates of the underground sector available, Géidigh, Schneider, and Blum (2016), uniquely provide a long time series that enables this study. 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.

To explain *EconGR*, we follow the standard neoclassical growth model of Mankiw, Romer, and Weil (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).[11] In contrast to Mankiw, Romer, and Weil (1992), we augment the neoclassical 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*), calculated via the currency demand method. As mentioned above, the literature has analyzed numerous influences on economic growth (see Barro and Sala-i-Martin 2003; Levine and Renelt 1992; Mankiw, Romer, and Weil 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.

B. 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., $I(1)$). 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 WWII.

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, Shin, and Smith (2001) based on an autoregressive distributed lag (ARDL) approach. Unlike traditional cointegration tests, such as Engle and 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 cointegration begins by estimating the following error correction model (e.g., Equation (8) of Pesaran, Shin, and Smith 2001, 293):

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

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

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

TABLE 2
Variable Definitions, Summary Statistics, and Sources

Variable	Definition	Mean	SD	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, Schularick, and Taylor (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*: Géidigh, Schneider, and Blum (2016)	15.30138	6.788992	5.4	36.9
Trade	Exports as a share of GDP. *Source*: Jordà, Schularick, and Taylor (2017)	0.058255	0.017476	0.027311	0.110821
Depression	Dummy variable equal to one for the years of the Great Depression (1929–1939), and zero otherwise.				
WWI	Dummy variable equal to one for the years spanning 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 (ADF)

Variable	ADF[a]	ADF-Break Point Test[b]
Shadow	−1.78	−2.44
	[.3887]	[.9169]
		Break date: 1943
Δ*Shadow*	−11.62***	−12.25***
	[.000]	[<.01]
EDU	1.27	−2.95
	[.644]	[.714]
		Break date: 1944
Δ*EDU*	−3.56***	−5.93***
	[.008]	[<.01]
INV	−2.80*	−4.92**
	[.061]	[.012]
		Break date: 1942
EconGR	−8.96***	−9.67***
	[.000]	[<.01]
		Break date: 1932

Notes: Schwartz Information Criterion (SIC) used to determine the 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.

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 eight 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. In the absence of serial correlation, the lagged regressors can be treated as predetermined, which therefore helps alleviate endogeneity issues.

The Bounds test is based on the partial *F*-test under the null of no cointegration ($\pi_1 = \pi_2 = \pi_3 = \pi_4 = 0$) 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, Shin, and Smith (2001) the distribution of the *F*-statistic is nonstandard regardless of whether the variables are *I*(0) or *I*(1). Therefore, Pesaran, Shin, and Smith (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 bounds then the test is inconclusive.

Given evidence of cointegration, the methodology proceeds to estimate the following ARDL error correction model

$$\begin{aligned}(3)\qquad \Delta EconGR_t = {} & \alpha_0 + \sum_{i=1}^{p_1} \gamma_i \Delta EconGR_{t-i} \\ & + \sum_{i=0}^{p_2} \lambda_i \Delta INV_{t-i} + \sum_{i=0}^{p_3} \delta_i \Delta EDU_{t-i} \\ & + \sum_{i=0}^{p_4} \theta_i \Delta Shadow_{t-i} + \phi_1 \mathrm{ECT}_{t-1} \\ & + Shocks_t^j + \varepsilon_t.\end{aligned}$$

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.

TABLE 4
Cointegration Test: Bounds Testing Procedure

Pre-WWII Sample (1870–1938)	
F-statistic ($k = 3$)	15.65^{***}
Post-WWII Sample (1946–2014)	
F-statistic ($k = 3$)	15.82^{***}

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

V. RESULTS

A. *Baseline Results*

The unit root test reveals a significant break in the data during WWII, 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 cointegration using the Bounds testing procedure outlined above based on Equation (2). The F-statistic for each subsample 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 cointegration (Pesaran, Shin, and Smith 2001).[12] Thus, the long-run estimates are super consistent, which further mitigates problems with endogeneity.[13]

Given evidence of cointegration, 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, 2, 0, 0) for the pre-WWII subsample and ARDL(6, 0, 0, 0) for the post-WWII subsample. 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 of 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, Durbin, and Evans 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 tests 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 cointegration estimates (Panel B). Focusing on the short-run results, it is interesting to note the difference in the dynamics between the pre-WWII sample and post-WWII sample. Specifically, economic growth responds positively to capital investment in the pre-WWII period and inertia in economic growth drives growth in the post-WWII period. Also, WWI has a positive and significant effect on economic growth, whereas the effect of the Great Depression is statistically insignificant. 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 1 year in the pre-WWII sample and a half a year in the post-WWII sample.[14] This is consistent with The Great Moderation idea. The effect of human capital investment is insignificant across both samples.[15]

Panel B of Table 5 reports estimates for the long-run parameters. Here too are some interesting differences. First, capital investment is

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

13. That is, ordinary least squares estimates of the long-run parameter in a cointegrating equation converge at a rate of $1/T$, instead of $1/\sqrt{T}$.

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

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

TABLE 5
ARDL Error Correction Model and Long-Run Coefficient Estimates

	Pre-WWII Sample (1870–1938)		Post-WWII Sample (1946–2014)	
	Coefficient	**Robust Standard Error**	**Coefficient**	**Robust Standard Error**
Panel A: ARDL error correction model				
$\Delta EconGR_{t-1}$			0.9505***	0.1621
$\Delta EconGR_{t-2}$			0.6690***	0.1205
$\Delta EconGR_{t-3}$			0.5167***	0.1016
$\Delta EconGR_{t-4}$			0.3124***	0.0944
$\Delta EconGR_{t-5}$			0.2000**	0.0859
ΔINV_t	1.2726***	0.2460		
ΔINV_{t-1}	0.8368***	0.2873		
Depression	−0.0174	0.0152		
WWI	0.0570**	0.0220		
ECT_{t-1}	−1.0802***	0.1181	−2.1708***	0.2361
Panel B: Long-run coefficients				
EDU	1.2362	3.3505	0.2122	0.8705
INV	−0.1637	0.2647	0.3411***	0.0768
Shadow	−0.0019*	0.0011	0.0010***	0.0003
C	0.0684	0.0562	−0.0654***	0.0185
Diagnostic tests				
Q-Stat (36)	27.77	[.477]	23.21	[.722]
Jarque-Bera test	0.63	[.730]	1.61	[.448]
Breusch-Pagan-Godfrey test	0.95	[.487]	0.78	[.634]

Notes: ECT_{t-1} is the error correction term, which captures deviations from the long-run equilibrium; *C* is a constant term and the other variables are defined in Table 2. Probability values are in brackets.
* $p < .1$; ** $p < .05$; *** $p < .01$.

statistically 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 (e.g., Mankiw, Romer, and Weil 1992). Based on elasticity, a 1% increase in investment leads to a 3% increase in economic growth. 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 based on respective means (see Table 2), a 1% increase in the shadow economy decreases economic growth by 1.5% before WWII and increases economic growth by 0.80% after WWII.[16] 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 (e.g., see for examples, Gollop, Fraumeni, and Jorgenson 1987). Comparing the relative elasticities, while it is not surprising that there are greater growth dividends from investment than the shadow sector, nevertheless, the dividends from the informal sector in the post-WWII period are not insignificant.

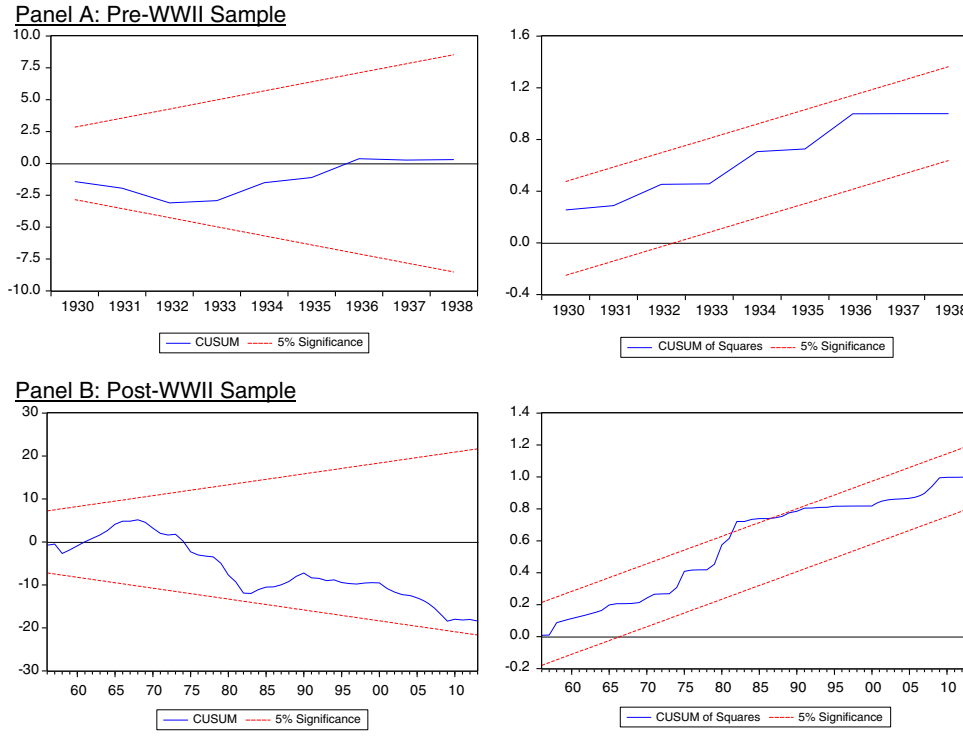
Next, we perform a few robustness checks to verify the validity of our findings. These include using an alternate estimation technique, considering an additional set of regressors, and employing a different sample period.

B. Robustness Check 1: Using Generalized Methods of Moments Estimation to Address Possible Endogeneity

To test the robustness of the long-run relationship between growth and its determinants, including the shadow economy, we estimate the

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

FIGURE 2
CUSUM and CUSUMSQ Tests for Parameter Stability. (A) Pre-WWII Sample and (B) Post-WWII Sample



long-run equation employing instrumental variables and estimating the long-run equation using generalized methods of moments. Without the availability of clear external instruments over a long time period, we instead use "internal" instruments and instrument *Shadow* using its third and fourth time lag. We also include a linear time trend as an additional exogenous instrument. These results are reported in Table 6. The insignificance of the Hansen J test suggests that the instruments are valid.

Focusing on the coefficient on *Shadow*, we find that the results are overall consistent with our main findings. That is, the shadow economy negatively affects the economic growth in the pre-WWII period, and while the effect on the postwar period is positive, it is statistically insignificant. Thus, the sanding effect of the shadow economy in the earlier period is robust to consideration of potential endogeneity.

Turning to the other determinants, we find that in the post-WWII period physical capital investment is positive and statistically significant with a larger magnitude compared to our baseline results. In the prewar period, both human capital and physical capital have a positive and significant effect on economic growth, while the effect of WWI is positive and significant and the Great Depression has a negative and significant effect.

C. Robustness Check 2: Considering the Impact of Foreign Trade

To account for the influence of international trade on economic growth, we augment the baseline growth relation with exports as a fraction of GDP and reestimate Equation (2). Greater openness to trade would affect both the formal and the informal sectors (both domestically and abroad). The results are reported in Table A1 in the Appendix. These results largely support the baseline models in that the coefficient on *Shadow* is negative and significant in the pre-WWII period and positive and insignificant in the post-WWII period. Thus, the findings about the

TABLE 6
Long-Run Coefficient Estimates Using Generalized Method of Moments

	Pre-WWII Sample (1870–1938)		Post-WWII Sample (1946–2014)	
	Coefficient	Robust Standard Error	Coefficient	Robust Standard Error
EDU	14.9588**	5.6842	−0.6921	3.1387
INV	0.4313*	0.2197	0.9932***	0.1874
Shadow	−0.0035**	0.0015	0.0023	0.0019
WWI	0.0740*	0.0399		
Depression	−0.0542*	0.0282		
C	−0.0207	0.0547	−0.2053***	0.0317
Diagnostic tests				
Hansen J Statistic	0.014 [.905]		0.074 [.786]	

Notes: C is a constant term and the other variables are defined in Table 2. *Shadow* is instrumented using its third and fourth lag, and a linear time trend is included as an additional exogenous instrument. Probability values are in brackets.

* $p < .1$; ** $p < .05$; *** $p < .01$.

growth effects of the shadow economy stand up to inclusion of trade or openness.

D. Robustness Check 3: Using a Different Sample Period

While the two time periods considered by us clearly dealt with pre- and post-WWII, it nevertheless seems useful to consider alternate time frames, especially since the pre-1946 period includes many significant developments, some of which we account for (e.g., WWI and the Great Depression). However, the Prohibition years (1920–1933) and the setup of the Federal Reserve (1913) were other significant developments that might have significantly affected growth and/or the shadow economy. While addressing each time period seems impractical and beyond the scope of the present study, we took the years from 1920 onward and redid the analysis. This period is post-WWI and the creation of the Federal Reserve.

The results (available upon request) showed the long-run effect of the shadow economy on growth to be positive and significant over this period. It is likely that some of the underground operations set up during prohibition might have persisted over time, with implications for growth. So the greasing effect of the shadow economy likely started before WWII.

Overall, we see that while the informal sector does have spillovers on growth in the formal sector, these spillovers could be negative or positive. This is consistent with the various possible underlying interactions between the two sectors and their relative influences over time. The concluding section follows.

VI. 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. In fact, the available estimates of the shadow economy used in the paper are the only long time series data.[17] An excellent recent review of the growth literature by Jones (2016) covers many aspects, but does not explicitly deal with the shadow economy-economic growth relation. In this sense, the present work, while focusing on the United States, has potential appeal for the larger literature.

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 neoclassical growth model, we use a relatively new time series technique due to Pesaran, Shin, and Smith (2001) to formally estimate the short-run

17. This exclusivity has the downside in that one is unable to do a robustness check with an alternate measure of the shadow economy.

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 insignificance of the Great Depression (in the pre-WWII sample) suggests that economic shocks did not have an appreciable impact during that time period, and the significance of WWI suggests that military shocks had an impact on economic growth. Finally, the shadow economy "sanded" economic growth before WWII, but "greased" growth in the postwar period.[18] The sanding effect of the shadow economy in the earlier period is especially robust to accounting for possible endogeneity and to the consideration of additional regressors (Sections V.B and V.C). We also considered an earlier period coinciding with the start of the Prohibition in 1920 (Section V.D), and found that the greasing effect of the shadow economy likely started before WWII. Further, we find differences in the speeds of adjustment to the long-run equilibrium in the two periods—adjustment to long-run equilibrium takes approximately 1 year in the pre-WWII sample and a half a year in the post-WWII sample.

While our results show a negative long-run effect of the shadow economy on economic growth over the 1870–1938 period (Table 5), the overall impact on growth during these years would be related to the net effect on the size of the shadow economy (and the compounding effects of other concurrent events such as the Great Depression and prohibition). The postwar period, on the other hand, likely benefited from a more consistent/predictable monetary policy under the stewardship of the Federal Reserve. This relative monetary stability/predictability likely improved synergies between the formal and informal sectors and were likely part of the reason for the positive growth effect of the shadow economy during this period.

Another cause of the different impact of the shadow economy during the post-WWII period is likely the rise of the activist Keynesian macroeconomic policies. The increased Keynesian stimuli over certain periods might have opened opportunities for both formal and informal sector entrepreneurs, spurring economic growth (see Jones 2016 for a broad overview of the literature). A contributing factor that we do not explicitly account for is the potential role of inflation. Levels and variability of inflation have been shown to significantly impact growth in some cases (Bruno and Easterly 1998). In the case of the United States, large inflation variability was seen during the Great Depression and again to a somewhat lesser extent during the seventies. We account for the former in our estimation, although it is not clear whether the variability in the shadow sector mimicked the variability in the formal sector prices. Other technological and social developments in recent decades have significantly affected the nature of commerce in both the formal and informal sectors. These include greater participation of women in the labor force (see Goel and Saunoris 2017), the rise of service economy, and the advent of the Internet (Andrés and Goel 2012). While our focus on the aggregate and broad growth determinants does not allow us to focus on the influences of these somewhat disaggregated channels, these influences could be driving the different response of the growth to the rise in the shadow economy in the postwar years. Obviously, this is an area worthy of formal investigations in the future.

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

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

APPENDIX: ROBUSTNESS CHECK USING *Trade* AS AN ADDITIONAL GROWTH DETERMINANT

TABLE A1
ARDL Error Correction Model and Long-Run Coefficient Estimates

	Pre-WWII Sample (1870–1938)		Post-WWII Sample (1946–2014)	
	Coefficient	**Robust Standard Error**	**Coefficient**	**Robust Standard Error**
Panel A: ARDL error correction model				
$\Delta EconGR_{t-1}$			0.9220^{***}	0.1441
$\Delta EconGR_{t-2}$			0.6229^{***}	0.1062
$\Delta EconGR_{t-3}$			0.4794^{***}	0.0906
$\Delta EconGR_{t-4}$			0.3040^{***}	0.0863
$\Delta EconGR_{t-5}$			0.1939^{**}	0.0791
ΔINV_t	1.2794^{***}	0.2455		
ΔINV_{t-1}	0.8420^{***}	0.2867		
Depression	−0.0137	0.0151		
WWI	0.0505^{**}	0.0218		
ECT_{t-1}	-1.1021^{***}	0.1200	-2.2067^{***}	0.2147
Panel B: Long-run coefficients				
EDU	2.467856	3.9120	1.6395^{*}	0.9488
INV	−0.13866	0.2561	0.3914^{***}	0.0806
Shadow	-0.00196^{*}	0.0011	0.0002	0.0005
Trade	0.299791	0.6010	-0.2422^{***}	0.0891
C	0.044503	0.0649	-0.0669^{***}	0.0185
Diagnostic tests				
Q-Stat (36)	27.19	[.508]	30.82	[.325]
Jarque-Bera test	0.76	[.685]	3.89	[.143]
Breusch-Pagan-Godfrey test	0.78	[.632]	0.56	[.836]

Notes: C is a constant term and the other variables are defined in Table 2. *Shadow* is instrumented using its third and fourth lag, and a linear time trend is included as an additional exogenous instrument. Probability values are in brackets.
$^{*}p < 0.1$; $^{**}p < .05$; $^{***}p < .01$.

REFERENCES

Adam, M. C., and V. Ginsburgh. "The Effects of Irregular Markets on Macroeconomic Policy: Some Estimates for Belgium." *European Economic Review*, 29(1), 1985, 15–33.

Ahumada, H., F. Alvaredo, and A. J. Canavese. "The Demand for Currency Approach and the Size of the Shadow Economy: A Critical Assessment." Berkeley Program in Law and Economics, Working Paper Series, 2006. Accessed July 2017. https://escholarship.org/uc/item/6zn9p98b.

Aigner, D. J., F. Schneider, and D. Ghosh. "Me and My Shadow: Estimating the Size of the U.S. Hidden Economy from Time Series Data," in *Dynamic Econometric Modelling, Proceedings of the Third International Symposium in Economic Theory and Econometrics*, edited by W. A. Barnett, E. R. Berndt, and H. White. Cambridge: Cambridge University Press, 1988, 297–334.

Andrés, A. R., and R. K. Goel. "Does Software Piracy Affect Economic Growth? Evidence across Countries." *Journal of Policy Modeling*, 34(2), 2012, 284–95.

Asea, P. K. "The Informal Sector: Baby or Bath Water? *Carnegie-Rochester Conference Series on Public Policy*, 45, 1996, 163–71.

Barro, R. J., and X. Sala-i-Martin. *Economic Growth*. Cambridge, MA: MIT Press, 2003.

Besozzi, C. *Illegal, legal – egal?: llegal, legal - egal? Zu Entstehung, Struktur und Auswirkungen illegaler Märkte*. Bern: Haupt Verlag, 2001.

Bhattacharyya, D. K. *How Does the "Hidden Economy" Affect Consumers' Expenditure? An Econometric Study of the U.K. (1960–1984)*. Berlin: International Institute of Public Finance (IIPF), 1993.

———. "On the Economic Rationale of Estimating the Hidden Economy." *The Economic Journal*, 109(456), 1999, 348–59.

Bitzenis, A., V. Vlachos, and F. Schneider. "An Exploration of the Greek Shadow Economy: Can Its Transfer into the Official Economy Provide Economic Relief amid the Crisis?" *Journal of Economic Issues*, 50(1), 2016, 165–96.

Bjørnskov, C. "Growth, Inequality, and Economic Freedom: Evidence from the U.S. States." *Contemporary Economic Policy*, 35(3), 2017, 518–31.

Brown, R. L., J. Durbin, and J. M. Evans. "Techniques for Testing the Constancy of Regression Relationships over Time." *Journal of the Royal Statistical Society, Series B*, 37(2), 1975, 149–92.

Bruno, M., and W. Easterly. "Inflation Crises and Long-Run Growth." *Journal of Monetary Economics*, 41(1), 1998, 3–26.

Cagan, P. "The Demand for Currency Relative to the Total Money Supply." *Journal of Political Economy*, 66(4), 1958, 303–28.

Duarte, P. "The Relationships between GDP and the Size of the Informal Economy: Empirical Evidence for Spain." *Empirical Economics*, 52(4), 2017, 1409–21.

Engle, R. F., and C. W. J. Granger. "Co-Integration and Error Correction: Representation, Estimation, and Testing." *Econometrica*, 55(2), 1987, 251–76.

Fatas, A. "Do Business Cycles Cast Long Shadows? Short-Run Persistence and Economic Growth." *Journal of Economic Growth*, 5(2), 2000, 147–62.

Feld, L. P., and F. Schneider. "Survey on the Shadow Economy and Undeclared Earnings in OECD Countries." *German Economic Review*, 11(2), 2010, 109–49.

Fichtenbaum, R. "The Productivity Slowdown and the Underground Economy." *Quarterly Journal of Business and Economics*, 28(3), 1989, 78–90.

Fleming, M. H., J. Roman, and G. Farrell. "The Shadow Economy." *Journal of International Affairs*, 53(2), 2000, 387–409.

Géidigh, D. M., F. Schneider, and M. Blum. "Grey Matters: Charting the Development of the Shadow Economy." CESifo Working Paper No. 6234, 2016.

Giles, D. E. A. "Measuring the Hidden Economy: Implications for Econometric Modelling." *The Economic Journal*, 109(456), 1999, 370–80.

Goel, R. K., and R. Ram. "Research and Development Expenditures and Economic Growth: A Cross-Country Study." *Economic Development and Cultural Change*, 42(2), 1994, 403–11.

Goel, R. K., and J. W. Saunoris. "Unemployment and International Shadow Economy: Gender Differences." *Applied Economics*, 49(58), 2017, 5828–40.

Goel, R. K., J. E. Payne, and R. Ram. "R&D Expenditures and U.S. Economic Growth: A Disaggregated Approach." *Journal of Policy Modeling*, 30(2), 2008, 237–50.

Goel, R. K., J. W. Saunoris, and F. Schneider. "Drivers of the Underground Economy around the Millienium: A Long Term Look for the United States." IZA Discussion Paper No. 10857, 2017.

Goldin, C. "Public and Private High School Graduates, by Sex and as a Percentage of All 17-Year-Olds: 1870–1997. Table Bc258-264," in *Historical Statistics of the United States, Earliest Times to the Present*. Millennial ed., edited by S. B. Carter, S. S. Gartner, M. R. Haines, A. L. Olmstead, R. Sutch, and G. Wright. New York: Cambridge University Press, 2006.

Gollop, F. M., B. M. Fraumeni, and D. W. Jorgenson. *Productivity and U.S. Economic Growth*. Cambridge, MA: Harvard University Press, 1987.

Gutmann, P. M. "The Subterranean Economy." *Financial Analysts Journal*, 33(6), 1977, 25–34.

Gyomai, G., and P. van de Ven. "The Non-Observed Economy in the System of National Accounts." OECD Statistics Brief No. 18, 2014. https://www.oecd.org/std/na/Statistics%20Brief%2018.pdf [Accessed July 2017].

Hassan, M., and F. Schneider. "Modelling the Egyptian Shadow Economy: A MIMIC Model and a Currency Demand Approach." *Journal of Economics and Political Economy*, 3(2), 2016, 309–39.

Houston, J. F. "Estimating the Size and Implications of the Underground Economy." Working Paper No. 87-9, Federal Reserve Bank of Philadelphia, 1987.

Isachsen, A. J., and S. Strøm. "The Size and Growth of the Hidden Economy in Norway." *Review of Income and Wealth*, 31(1), 1985, 21–38.

Jerzmanowski, M. "Finance and Sources of Growth: Evidence from the U.S. States." *Journal of Economic Growth*, 22(1), 2017, 97–122.

Johansen, S., and K. Juselius. "Maximum Likelihood Estimation and Inference on Cointegration—with Applications to the Demand for Money." *Oxford Bulletin of Economics and Statistics*, 52(2), 1990, 169–210.

Johnston, L., and S. H. Williamson. "What Was the U.S. GDP Then? Measuring Worth." 2017. Accessed June 2017. http://www.measuringworth.org/usgdp/

Jones, C. I. "The Facts of Economic Growth," in *Handbook of Macroeconomics*, Vol. 2A, Chapter 1, edited by J. B. Taylor and H. Uhlig. Amsterdam: Elsevier, 2016, 3–69.

Jordà, Ò., M. Schularick, and A. M. Taylor. "Macrofinancial History and the New Business Cycle Facts," in *NBER Macroeconomics Annual 2016*, Vol. 31, edited by M. Eichenbaum and J. A. Parker. Chicago: University of Chicago Press, 2017.

Kalaitzidakis, P., T. P. Mamuneas, A. Savvides, and T. Stengos. "Measures of Human Capital and Nonlinearities in Economic Growth." *Journal of Economic Growth*, 6(3), 2001, 229–54.

Levine, R., and D. Renelt. "A Sensitivity Analysis of Cross-Country Growth Regressions." *American Economic Review*, 82(4), 1992, 942–63.

Loayza, N. V. "The Economics of the Informal Sector: A Simple Model and Some Empirical Evidence from Latin America." *Carnegie-Rochester Conference Series on Public Policy*, 45, 1996, 129–62.

Lubell, H. *The Informal Sector in the 1980s and 1990s*. Paris: OECD Publishing, 1991.

MacKinnon, J. G. "Numerical Distribution Functions for Unit Root and Cointegration Tests." *Journal of Applied Econometrics*, 11(6), 1996, 601–18.

Mankiw, N., D. Romer, and D. Weil. "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics*, 107(2), 1992, 407–37.

McGee, R. T., and E. L. Feige. "Policy Illusion, Macroeconomic Instability, and the Unrecorded Economy," in *The Underground Economies: Tax Evasion and Information Distortion*, edited by E. L. Feige. Cambridge: Cambridge University Press, 1989, 81–110.

Méon, P.-G., and K. Sekkat. "Does Corruption Grease or Sand the Wheels of Growth?" *Public Choice*, 122(1–2), 2005, 69–97.

Neck, R., M. F. Hofreither, and F. Schneider. "The Consequences of Progressive Income Taxation for the Shadow Economy: Some Theoretical Considerations," in *The Political Economy of Progressive Taxation*, edited by D. Boes and B. Felderer. Heidelberg: Springer, 1989, 149–76.

Panizza, U. "Income Inequality and Economic Growth: Evidence from American Data." *Journal of Economic Growth*, 7(1), 2002, 25–41.

Payne, J. E. "The Long-Run Relationships among Regional Housing Prices: An Empirical Analysis of the U.S." *Regional Analysis & Policy*, 42(1), 2012, 28–35.

Pesaran, M. H., and B. Pesaran. *Microfit 4.0: Interactive Economics Analysis*. Oxford: Oxford University Press, 1997.

Pesaran, M. H., and Y. Shin. "An Autoregressive Distributed-Lag Modelling Approach to Cointegration Analysis." *Econometrics Society Monographs*, 31, 1998, 371–413.

Pesaran, M. H., Y. Shin, and R. J. Smith. "Bounds Testing Approaches to the Analysis of Level Relationships." *Journal of Applied Econometrics*, 16(3), 2001, 289–326.

Pommerehne, W. W., and F. Schneider. "The Decline of Productivity Growth and the Rise of the Shadow Economy in the U.S." Working Paper No. 85:9, University of Aarhus, Aarhus, Denmark, 1985.

Quirk, P. J. "Macroeconomic Implications of Money Laundering." IMF Working Paper No. WP/96/66, 1996.

Saunoris, J. W. "Is the Shadow Economy a Bane or Boon for Economic Growth?" *Review of Development Economics*, 22(1), 2018, 115–32.

Schneider, F. "Estimating the Size of the Danish Shadow Economy Using the Currency Demand Approach: An Attempt." *The Scandinavian Journal of Economics*, 88(4), 1986, 643–68.

———. "Measuring the Size and Development of the Shadow Economy. Can the Causes Be Found and the Obstacles Be Overcome?" in *Essays on Economic Psychology*, edited by H. Brandstaetter and W. Güth. Heidelberg: Springer, 1994a, 193–212.

———. "Can the Shadow Economy Be Reduced through Major Tax Reforms? An Empirical Investigation for Austria." *Public Finance/ Finances Publiques*, 49, 1994b, 137–52.

———. "Stellt das Anwachsen der Schwarzarbeit eine wirtschaftspolitische Herausforderung dar?" Einige Gedanken aus volkswirtschaftlicher Sicht. Linz, Mitteilungen des Instituts für angewandte Wirtschaftsforschung (IAW), I/98, 1998, S. 4–13.

———. "Shadow Economies around the World: What Do We Really Know?" *European Journal of Political Economy*, 21(3), 2005, 598–642.

———. "Shadow Economies and Corruption of 145 Countries All Over the World: What Do We Really Know?" IZA Discussion Paper No. 2315, 2006.

———. "The Influence of Public Institutions on the Shadow Economy: An Empirical Investigation for OECD Countries." *Review of Law & Economics*, 6(3), 2010, 441–68.

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

Schneider, F., and A. Buehn. "Estimating the Size of the Shadow Economy: Methods, Problems and Open Questions." IZA Discussion Paper No. 9820, 2016.

Schneider, F., and D. H. Enste. "Shadow Economies: Size, Causes, and Consequences." *Journal of Economic Literature*, 38(1), 2000, 77–114.

———. *The Shadow Economy—An International Survey*. Cambridge: Cambridge University Press, 2002.

Schneider, F., and B. Hametner. "The Shadow Economy in Colombia: Size and Effects on Economic Growth." *Peace Economics, Peace Science, and Public Policy*, 20(2), 2014, 293–325.

Schneider, F., and C. C. Williams. *The Shadow Economy*. London: London Institute of Economic Affairs, 2013.

Schneider, F., M. F. Hofreither, and R. Neck. "The Consequences of a Changing Shadow Economy for the Official Economy: Some Empirical Results for Austria," in *The Political Economy of Progressive Taxation*, edited by D. Boes and B. Felderer. Heidelberg: Springer, 1989, 181–211.

Tanzi, V.. "The Underground Economy in the United States: Estimates and Implications." *Banca Nazionale del Lavoro Quarterly Review*, 135(4), 1980, 427–53.

———. "The Underground Economy in the United States: Annual Estimates, 1930-80." *IMF Staff Papers*, 30(2), 1983, 283–305.

———. "Uses and Abuses of Estimates of the Underground Economy." *The Economic Journal*, 109(456), 1999, F338–47.

Temple, J. "The New Growth Evidence." *Journal of Economic Literature*, 37(1), 1999, 112–56.

Vogelsang, T. J. Unpublished Computer Program. 1993.

Williams, C. C. *The Hidden Enterprise Culture: Entrepreneurship in the Underground Economy*. Cheltenham, UK: Edward Elgar Publishing, 2006.

Williams, C. C., and F. Schneider. *Measuring the Global Shadow Economy: The Prevalence of Informal Work and Labour*. Cheltenham, UK: Edward Elgar Publishing Company, 2016.

Wiseman, T. "Economic Freedom and Growth in U.S. State-Level Market Incomes at the Top and Bottom." *Contemporary Economic Policy*, 35(1), 2017, 93–112.