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Ceyhun Elgin
Serdar Birinci

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GROWTH AND INFORMALITY: A COMPREHENSIVE PANEL DATA ANALYSIS

Ceyhun Elgin[*]
Bogazici University

Serdar Birinci
University of Minnesota

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In this paper we empirically explore the impact of the presence of informal economies on long-run economic growth. Using a novel panel dataset of 161 countries over the period from 1950 to 2010 we obtain an inverted-U relationship between informal sector size and growth of GDP per capita. That is, small and large sizes of the informal economy are associated with little growth and medium levels of the size of the informal economy are associated with higher levels of growth. We also observe that in high (low) income economies, informal economy size is positively (negatively) correlated with growth. Moreover, when we decompose growth into several components using a simple growth accounting framework, we find that informality is mainly associated with growth in TFP and that this association is different in high and low-income economies.

JEL classification codes: E26, O17, O47
Key words: informal economy, growth accounting, panel data

I. Introduction

One of the most debated issues in economics is the identification of the main determinants of long-run economic growth. Although our understanding of the

[*] Elgin (corresponding author): Bogazici University, Department of Economics, Natuk Birkan Kat:2, Bebek, 34342, Istanbul – Turkey; email: ceyhun.elgin@boun.edu.tr; telephone: +90-212-359-7653. Birinci: University of Minnesota, Department of Economics, 1925 4th Street S. Hanson Hall: 4-101 55455, MN, USA; email: birin001@umn.edu.

topic has improved significantly, various questions on growth still remain under-investigated. One such issue is the impact of the extent of informality on economic growth.

To address this gap in the literature, in this paper we bring two strands of the literature together and provide empirical evidence on the impact of the presence of the informal economy on growth of real GDP per capita for a panel of 161 advanced and emerging market economies in the period from 1950 to 2010. Taking into account a wide range of determinants of growth, as well as various different econometric specifications, we obtain an inverted-U relationship between informal sector size and growth of GDP per capita. That is, our results imply that small and large sizes of the informal economy are associated with little growth and medium levels of the size of the informal economy are associated with higher levels of economic growth. When we further examine the roots of this non-linearity, we observe that the level of GDP per capita significantly interacts with the relationship between informality and growth. Specifically, in high (low) income economies, informal economy size is positively (negatively) correlated with growth. Moreover, when we decompose growth into three different growth accounts using a simple growth accounting framework, i. e. growth in total factor productivity (TFP), growth in capital-output ratio and growth in labor, we find that a larger informal economy is associated with lower growth rates of labor and capital-output ratio and a higher growth rate of the TFP. In other words, informality is negatively related to two of the three growth accounts and positively related to one. Finally, we also show that the association between the three growth accounts and informality significantly interacts with GDP per capita, as well. We argue that this final observation might provide the key for the non-linearity of growth-informality relationship.

The rest of the paper is organized as follows: In the next section, we provide a comprehensive review of the related literature. In the third section, we describe the empirical methodology as well as our dataset. Next, in the fourth section we present the results of our benchmark empirical analysis. Then, in section five we describe a theoretical growth accounting framework through which the informal economy might be associated with economic growth and its accounts. In this section we also present empirical results on the relationship between informality and growth accounts. Finally, in the last section we conclude.

II. Literature review

Considering the current literature, there are two separate aspects when one intends to investigate the relationship between growth and informality. One stream of the literature associates larger informality with lower growth, another stream argues the opposite.

On the one hand, a larger informal economy could be associated with lower growth for a number of different reasons: First, a third factor, such as excessive regulation, could lead to a larger informal sector as well as reduce economic growth (Sarte 2000; Loayza, Oviedo and Serven 2004). Second, a large informal economy could severely limit government resources to finance several public goods such as education, health, or infrastructure investment, thereby reducing potential growth. For example, Loayza (1997) presents empirical evidence for Latin American countries and finds that the enlargement of the informal economy hurts economic growth since it decreases the availability of public services for all agents in the economy and increases the inefficient usage of public services. Similarly, Johnson et al. (1997) obtains a negative relationship between growth and informality by presenting empirical evidence for 25 transition economies.

Besides this macro-level evidence, some micro-level studies suggest that the informal economy is a growth obstacle due to a number of different reasons. Regarding the influences of informality on economic performance, De Soto (1989) states that the fear of detection by authorities forces informal firms to operate on a smaller scale, which prevents them from attaining efficient scale and therefore reduces economic growth. As an empirical support of this argument, using data from 6797 businesses from the Indian state of Kerala, Raj and Seethamma (2007) find that informal manufacturing firms in Kerala suffer from technological inefficiency and are able to produce only 48 percent of their potential output. In a related study, Benjamin and Mbaye (2010) investigate the productivity differences among formal and informal firms by using data from 900 businesses in Benin, Burkina Faso and Senegal. The authors' findings indicate that formal firms exhibit higher productivity levels compared to informal firms. Similarly, in another micro-level study, using survey data from 6402 households in Mozambique, Byiers (2009) finds that non-agricultural micro-enterprises that are formally registered are more productive compared to their informal counterparts. By using both firm-level and individual-level data from Turkey, Taymaz (2009) finds empirical evidence supporting the existence of a productivity gap between

formal and informal firms and concludes that this productivity gap stems from reduced access to public service and infrastructure as well as markets. Finally, in a study by Amin (2009) on Ivory Coast, Madagascar and Mauritus, empirical results indicate that formal manufacturing enterprises exhibit higher levels of productivity compared to informal enterprises. In addition to productivity differences between formal and informal firms, access to credit provides yet another channel that might associate larger informality to lower growth. For example, Massenot and Straub (2011) conclude that in an open economy it is better to have a larger formal sector for economic growth because formality facilitates firms to collateralize their assets in a more efficient way leading to more investment and higher productivity. Similarly, Gatti and Honorati (2008), utilizing tax compliance as proxy for informality and using firm level-data for 49 developing countries, find that tax compliance (or formality) is positively and significantly correlated with access to credit which is identified as a fundamental source of growth. Straub (2005) is yet another example illustrating the credit market channel in identifying the negative effect of informality on growth. Furthermore, in a similar study, Caro, Galindo and Melendez (2012) find that labor informality is negatively and significantly correlated with access to credit, firm performance and employment growth in Colombia. Finally, the results of Morón, Salgado and Seminario (2012) for Peru show that the reduction of self-employment and firms with less than 10 workers increases access to credit and the increased availability of credit in turn helps these small firms to grow at larger rates.

On the other hand, some economists argue that having a larger informal sector might bring some benefits for economic growth. Firms in the informal sector tend to be less productive (Levy 2008; La Porta and Shleifer 2008), employ lower-skilled workers, operate with less capital (Amaral and Quintin 2006) and are generally less able to absorb the cost of operating in the formal sector. This adverse selection in itself could raise productivity levels in the formal economy in countries with larger informal economies (D'Erasmo and Moscoso Boedo, 2011). However, the impact on productivity growth is unclear. For instance, Nabi and Drine (2009) conclude that an increase in the size of shadow economy could be accompanied by higher economic growth if a subsequent reduction in the size of the formal economy is offset by the increase in productivity of the formal sector. In yet another study by Eliat and Zinnes (2000) the authors show that the presence of a large shadow economy decreases the amplitude of a recession in official GDP. Furthermore, Eliat and Zinnes (2002) list several potential factors that associate larger informal sector both with higher and lower growth and also

provide some evidence for transition economies and illustrate that the relationship between growth and informality might actually be non-linear. Finally, in another paper by Elgin and Uras (2013) the authors show that if the capacity constraints of the formal financial institutions are binding, lowering the size of the informal sector would retard the level of financial development and therefore would harm economic growth.

Our paper aims to contribute to the literature on the growth effects of informality by utilizing the largest available macroeconomic dataset. To the best of our knowledge, our paper is unique in the literature in investigating the empirical relationship between growth and informality using an annual cross-country panel dataset of 161 countries with a 61-year time series span. Moreover, our main result illuminating the non-linearity of the relationship between growth and informality and its interaction with per capita income is also novel and has the potential to open up further contributions in the literature. Finally, our empirical results also have relevant implications for the design of economic policy that aims to reduce informality and achieve optimal growth.

III. Empirical analysis

In this section, we conduct a comprehensive econometric analysis to find out the nature of the relationship between growth and informality.

A. Econometric methodology

We run a number of regressions using different estimators. The benchmark panel fixed-effects regression we use is given by the following expression:

$$GR_{i,t} = \beta_0 + \beta_1 IS_{i,t} + \beta_1 IS_{i,t}^2 + \sum_{k=3}^{n} \beta_k X_{ki,t} + \theta_i + \gamma_t + \varepsilon_{i,t},$$

where $GR_{i,t}$ is growth rate of GDP per capita in country i, in year t, $IS_{i,t}$ is the informal sector size as % of GDP, $X_{ki,t}$ denotes other explanatory (control) variables in addition to informal sector, θ_i, γ_t are the country and period fixed effects, and $\varepsilon_{i,t}$ denotes the error term. In our regressions, we include informal sector size-squared among the independent variables to check for the potential existence of a non-linear relationship between informal sector size and growth.

In most regressions we use the fixed-effects (FE) estimator. However, we also report results of further regressions using different estimators such as the between estimator (BE), ordinary least squares (OLS) in the static panel data setting. Moreover, to address potential endogeneity issues we also run regressions using an IV estimator where one-period lagged values of independent variables are used as instruments for their levels. Finally, to capture persistence and also potentially mean-reverting dynamics in the growth rates of GDP per capita, we also report results of a dynamic panel data estimation using the GMM estimator developed by Arellano and Bond (1991) where one-period lagged values of the regressors are used as instruments. In this case we estimate the following equation:

$$GR_{i,t} = \beta_0 + \beta_1 GR_{i,t-1} + \beta_2 IS_{i,t} + \beta_3 IS^2_{i,t} + \sum_{k=4}^{n} \beta_k X_{ki,t} + \theta_i + \gamma_t + \varepsilon_{i,t}.$$

In the dynamic panel data estimations, p-values corresponding to two standard tests are also provided in all of the tables. One of these tests is the Hansen J-test for over-identifying restrictions and the other one is the AR (2) test for autocorrelation. The tests provide support for the exogeneity of the instruments and absence of autocorrelation in the specified order, respectively.

B. Data

Our dataset is an annual cross-country panel data covering 161 economies in the period from 1950 to 2010. In all the reported regressions, we will use five-year averages to rule out business cycle effects, as is standard in the growth literature. In addition to growth and informal sector size, we use several control variables in our econometric analysis. Table 1 provides descriptive statistics of all the variables used. Generally, our choice of control variables is motivated by the ones used in the existing empirical growth literature. Specifically, we control for GDP per capita, trade openness, government expenditure, inflation, fiscal deficit, financial depth, and two institutional quality variables, namely the corruption control, and law and order, indices.

Table 1. Summary statistics of 1950-2009 dataset

Variable	Description	Mean	Std. dev.	Minimum	Maximum	Observations
Growth	Growth (%)	2.31	7.19	-27.12	29.13	7484
IS	Informal sector size (% GDP)	36.54	14.78	8.07	80.33	7395
GDPpc	GDP per capita (thousand USD)	8.37	11.31	0.12	159.14	7645
Open	Openness (% GDP)	68.43	49.23	2.32	443.18	7645
Govexp	Government expenditure (% GDP)	10.83	7.27	0.28	58.60	7645
Inf	Inflation (%)	6.20	13.19	-12.18	153.12	4711
Corrcont	Corruption control	3.13	1.38	0.00	6.00	2812
Law	Law and order	3.67	1.52	0.00	6.00	2812
Fiscdef	Fiscal deficit	-0.71	4.20	-19.12	49.55	2112
Findep	Financial depth (M2 as % GDP)	46.01	40.10	3.12	279.80	2103
K/Y	Capital-output ratio	1.90	0.86	0.23	11.68	7144
TFP	TFP growth (%)	1.31	6.74	-47.52	72.90	7000
Lab	Employment (ratio to population)	0.41	0.08	0.19	0.66	7000

Among these variables we expect trade openness, financial depth, corruption control and law and order to be positively correlated with economic growth.[1] As for the estimated coefficients of inflation, government spending and GDP per capita; our expectations are ambiguous; as the existing empirical studies in general produce conflicted results depending on the time window or the sample of the analysis.

The informal sector (as % of GDP) data in the benchmark analysis is obtained from Elgin and Oztunali (2012).[2] The authors obtain the informal economy series from a two-sector dynamic general equilibrium model after calibrating the model

[1] We also ran several regressions with different control variables, such as public debt (as % of GDP), indicator variables for different legal systems a là La Porta et al. (1999), political system (presidential vs. parliamentary), and predominant religion, as well as various institutional quality indices such as bureaucratic quality, ethnic conflict, and investment profile indices. Since we obtained qualitatively similar results, these are not reported due to space constraints but are available from the corresponding author upon request.

[2] In the following section we also use a different informal sector data to check for robustness

and then plugging in the observed data. We obtained the data series on growth, GDP per capita, employment, (trade) openness (defined as the ratio of the sum of exports and imports to GDP), and government expenditure from Penn World Tables 7.1 (PWT). Similarly, the capital-output ratio, and TFP series are constructed using data from PWT. Series for inflation, financial depth (measured by the ratio of the broad monetary aggregate M2 to GDP) and fiscal deficit are obtained from the World Development Indicators (WDI). Finally, two institutional quality indices, corruption control and law and order indices are taken from the International Country Risk Guide (ICRG) of the PRS Group. These are the variables which are most widely used in the empirical growth literature.

IV. Empirical analysis

Before we proceed to the estimation results, we should acknowledge that informality might actually be associated with some of the control variables. For example, some of the right hand side variables in our regressions such as the institutional quality variables, GDP per capita, trade openness, government spending, and inflation might be significantly correlated with informal sector size, another right hand side variable. Furthermore, considering that informal sector size is by definition imperfectly measured, measurement error, as well as the potential existence of a two-way causality between informal sector size and growth and existence of potentially omitted variables might also lead to the presence of endogeneity in our regression analysis.

We aim to overcome these potential problems with several robustness checks with respect to sample size, estimation method, and data stratification. Several tests of endogeneity and collinearity, as well as an analysis of the variance inflation factors calculated after the regressions, do not indicate the existence of a serious issue in this respect.

A. Benchmark results

Results for the benchmark estimation using the FE estimator for the whole dataset are reported in Table 2. Here we include every control variable one by one in each additional regression. Considering that the estimated coefficient of the linear term for the informal sector is positive and that of the squared term is negative in all the nine regressions, we observe a significant and robust inverted-U relationship

between growth rate of GDP per capita and informal economy size. Evidently this relationship is robust to the inclusion of various control variables in the regression equation. In addition to the coefficients of the informal sector size, government expenditure and trade openness are the other two variables that consistently have significant coefficients in all regressions. Accordingly, a smaller amount of government spending and a higher degree of openness to international trade are associated with a higher growth rate of GDP per capita.

Table 2. Growth and informality: FE estimations

	1	2	3	4	5	6	7	8	9
IS	0.72*	0.74*	0.72*	0.81*	0.79*	0.75*	0.73*	0.74*	0.68*
	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)
IS2	-0.61*	-0.62*	-0.60*	-0.70*	-0.75*	-0.77*	-0.79*	-0.78*	-0.80*
	(0.07)	(0.07)	(0.07)	(0.07)	(0.09)	(0.10)	(0.08)	(0.09)	(0.09)
Open		0.01***	0.01***	0,001	0.02**	0.02**	0.02***	0.02**	0.02**
		(0.005)	(0.005)	(0.005)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Govexp			-0.09*	-0.06***	-0.09**	-0.08**	-0.09**	-0.08**	-0,07
			(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
GDPpc				0.001*	0.002**	0.002**	0,001	0,001	0,001
				(0.0003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inf					-0,53	-0.57***	-0,44	-0,45	-0,48
					(0.30)	(0.30)	(0.40)	(0.41)	(0.41)
Corrcont						0,57	0,54	0,5	0,51
						(0.48)	(0.46)	(0.45)	(0.43)
Law							1,1	1,19	1,15
							(0.88)	(0.76)	(0.73)
Fiscdef								-0.29**	-0,25
								(0.15)	(0.15)
Findep									0,17
									(0.99)
R-squared	0,15	0,15	0,16	0,17	0,18	0,18	0,18	0.20	0,21
Observations	1366	1366	1366	1366	1199	826	825	816	813
F-test	17,45	16,4	15,78	16,26	15,21	14,77	13,76	13,62	12,1
Time F-test	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,01	0,01

Note: All panel regressions include a country fixed effect. Robust standard errors are reported in parentheses. *, **, *** denote 1, 5 and 10% confidence levels. In all regressions a constant is included but not reported.

B. Robustness checks

In this subsection we conduct several robustness checks of the observed inverse-U relationship we obtained in the previous subsection. Specifically, we conduct three different types of robustness checks. First, we employ different estimators other than the FE estimator, next we use different measures of informal sector size and finally we stratify our dataset and estimate the hypothesized relationships in several subsets of the data.

Different estimators

As the first robustness checks of our results, in Table 3 we report results of several regressions using the BE, OLS, GMM and IV estimators mentioned in the previous section. Here we only report results of two estimations for each different estimator, one with only informal sector as the explanatory variable and one with a full set of regressors.[3] In the BE and IV estimations we have an additional regressor, the initial GDP per capita for each country. On the other hand for the dynamic GMM estimation, we also have the one year lagged dependent variable within the regressors. We observe from Table 3 that our results (specifically and most importantly the inverted-U relationship between growth of GDP per capita and informal economy size) are also robust to the use of different estimators. Specifically, in all these estimations, the coefficient of the informal sector size variable is positive and the one of the squared term is negative. Other than these variables, none of the independent variables produce a consistently significant estimate across different estimators. However, according to the BE, GMM and OLS estimations, a higher inflation rate is significantly associated with lower growth. Moreover, for the BE estimation a higher corruption control index, for the GMM estimation a higher value of the one period lagged value of the growth rate of GDP per capita, and for the OLS estimation a higher corruption control index and lower government spending are associated with a higher growth rate of GDP per capita. Finally, both the BE and OLS estimations associate a higher initial GDP per capita with lower growth supporting convergence arguments to some extent.

[3] A full set of 9 regressions for the BE, GMM, OLS and IV estimations are provided in Tables A1, A2, A3 and A4 of the online appendix.

Table 3. Growth and informality: different estimators

	FE	FE	BE	BE	OLS	OLS	GMM	GMM	IV	IV
IS	0.72*	0.68*	0.25*	0.35*	0.21*	0.26*	0.93**	0.75*	0.71*	0.74*
	(0.07)	(0.07)	(0.09)	(0.08)	(0.06)	(0.08)	(0.42)	(0.27)	(0.18)	(0.20)
IS2	-0.61*	-0.80*	-0.34*	-0.48*	-0.24*	-0.23*	-0.65**	-0.59**	-0.68*	-0.71*
	(0.07)	(0.09)	(0.12)	(0.1)	(0.07)	(0.08)	(0.32)	(0.29)	(0.23)	(0.27)
Open		0.02**		0.04*		0.03*		0.08***		0.06**
		(0.01)		(0.01)		(0.01)		(0.05)		(0.03)
Govexp		-0.07***		-0.05***		-0.05**		-0.01		-0.01
		(0.04)		(0.03)		(0.02)		(0.05)		(0.02)
GDPpc		0.001		0.002		0.001		0.0002		0.0003
		(0.001)		(0.004)		(0.001)		(0.0002)		(0.0002)
Inf		-0.48		-0.82**		-0.37*		-0.28*		-0.19***
		(0.41)		(0.41)		(0.13)		(0.11)		(0.11)
Corrcont		0.51		1.01**		0.94**		0.70		0.65
		(0.43)		(0.45)		(0.44)		(0.54)		(0.55)
Law		1.15		0.68		0.95		0.31		0.34
		(0.73)		(0.72)		(0.82)		(0.69)		(0.66)
Fiscdef		-0.25		(0.15)		-0.05***		-0.05		-0.04
		(0.15)		(0.15)		(0.03)		(0.05)		(0.05)
Findep		0.17		0.87		(0.07)		(0.97)		-0.54
		(0.99)		(1.02)		(0.82)		(1.02)		(0.92)
IGDPpc				-0.02***		-0.01***				
				(0.01)		(0.006)				
Lgrowth							0.05**	0.05**		
							(0.02)	(0.02)		
R-squared	0.15	0.21	0.06	0.18	0.04	0.24			0.33	0.37
Observations	1366	813	1366	813	1366	813	1105	582	1240	699
F-test	17.45	12.1	4.57	3.96	10.46	7.13				
Hansen J-test							0.29	0.38	0.33	0.21
AR-2 test							0.24	0.27		

Note: All panel regressions include a country fixed effect. Robust standard errors are reported in parentheses. *, **, *** denote 1, 5 and 10% confidence levels. In all regressions a constant is included but not reported. *IGDPpc* and *Lgrowth* stand for initial GDP per capita and lagged growth, respectively.

Different informality measures

Next, in Table 4 we report another set of regressions, now using different informality measures obtained using different approaches to measure the extent of informality for an economy. Under the column titled MIMIC (originating from the name of the approach, i.e., multiple-indicators-multiple-causes), we use the panel estimates of Buehn and Schneider (2012), who report annual informal economy data for 162 countries from 1999 to 2007. As this is a highly balanced panel data, we estimate our hypothesized relationship using all the four estimators we used above.

Table 4. Growth and informality: alternative measures of informality

	MIMIC				SE		IE	
	BE	FE	GMM	OLS	OLS	FE	OLS	FE
IS	0.19**	0.35*	0.34*	0.29*	0.44**	0.45**	0.33**	0.34**
	(0.09)	(0.09)	(0.07)	(0.08)	(0.19)	(0.18)	(0.17)	(0.16)
IS2	-0.14*	-0.24*	-0.22*	-0.19*	-0.24**	-0.26*	-0.29*	-0.30*
	(0.05)	(0.06)	(0.05)	(0.06)	(0.11)	(0.10)	(0.08)	(0.09)
Open	0.02**	0.03*	0.01**	0.04**	0.02	0.02	0.01***	0.01**
	(0.01)	(0.01)	(0.005)	(0.02)	(0.02)	(0.02)	(0.006)	(0.005)
Govexp	-0.04	0.02	0.04	0.05	-0.09***	-0.12**	0.09	0.07
	(0.04)	(0.05)	(0.03)	(0.05)	(0.05)	(0.06)	(0.08)	(0.10)
GDPpc	0.01	0.01	0.02	0.01	0.002	0.002	0.01	0.01
	(0.05)	(0.04)	(0.04)	(0.04)	(0.002)	(0.002)	(0.02)	(0.02)
Inf	-0.09	-0.10	-0.14**	-0.09	-0.13**	-0.18*	-0.20*	-0.24*
	(0.08)	(0.08)	(0.05)	(0.07)	(0.06)	(0.06)	(0.07)	(0.09)
Corrcont	0.21**	0.28**	0.33*	0.19**	0.32*	0.41*	0.98**	0.95**
	(0.10)	(0.12)	(0.10)	(0.09)	(0.08)	(0.09)	(0.46)	(0.47)
Law	0.19	0.20	0.05	0.17	0.16	0.18	0.10	0.17
	(0.15)	(0.14)	(0.18)	(0.16)	(0.19)	(0.19)	(0.27)	(0.29)
Fiscdef	-0.17	-0.09	-0.20	-0.17	-0.11	-0.15	-0.16**	0.18**
	(0.16)	(0.15)	(0.29)	(0.16)	(0.22)	(0.21)	(0.08)	(0.08)
Findep	0.77	0.80	0.04	0.76	0.55	0.49	0.33	0.35
	(0.51)	(0.52)	(0.44)	(0.52)	(0.44)	(0.43)	(0.52)	(0.50)
Lgrowth			0.11**					
			(0.05)					
R-squared	0.08	0.25		0.23	0.49	0.52	0.44	0.56
Observations	1204	1204	905	1024	290	290	95	95
F-test	4.08	18.11		8.12	9.08	13.47	8.90	12.11
Hansen J-test			0.33					
AR-2 test			0.34					

Note: All panel regressions include a country fixed effect. Robust standard errors are reported in parentheses. *, **, *** denote 1, 5 and 10% confidence levels. In all regressions a constant is included but not reported. *Lgrowth* denotes lagged growth.

Next, under SE, we use the percentage share of self-employed and, under IE, the percentage share of informal employment in total non-agricultural employment. We obtained both of these series from Charmes (2009). As the data for informal employment is usually very limited, self-employment is a widely used proxy for informal employment. In both cases estimates are obtained from countrywide surveys. In the case of informal employment the data spans from 1975 to 2007 in five-year intervals. On the other hand, in the case of self-employment the time span is from 1970s to 2000s in ten-year intervals. The only variable that has a consistently significant coefficient across different measures is the corruption control index.

In all three cases, estimation results again support our hypothesis in favor of the existence of the inverted-U relationship between informal economy size and growth of GDP per capita. Particularly, in all these estimations, the coefficient of the informal sector size variable is positive and the one of the squared term is negative.

Sub-sample analysis

Next, as the final robustness check, we stratify our dataset into different subsets and estimate the same hypothesized relationship in these subsets of our data. The results are reported in Table 5.[4]

Table 5. Growth and informality: different country groups (FE Estimator)

	OECD-EU	Asia	Latin	Subsaharan	Transition	Developed	Developing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
IS	0.70*	0.42*	0.95*	1.12*	2.04*	1.21*	0.47*
	(0.09)	(0.14)	(0.12)	(0.18)	(0.48)	(0.12)	(0.11)
IS2	-0.48*	-0.39*	-0.72*	-0.87*	-1.20*	-1.07*	-1.14*
	(0.09)	(0.13)	(0.11)	(0.17)	(0.40)	(0.14)	(0.14)
Open	0.03*	-0.01	0.01	-0.001	-0.07***	0.01***	-0.002
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.007)	(0.007)
Govexp	-0.08	0.09	-0.02	0.02	-0.15	-0.01	0.0004
	(0.07)	(0.09)	(0.05)	(0.07)	(0.23)	(0.06)	(0.05)
GDPpc	0.0003	0.001**	0.008*	0.004	0.01**	0.002*	0.05*
	(0.0003)	(0.0005)	(0.001)	(0.002)	(0.004)	(0.0003)	(0.005)
Inf	-0.25	-0.44**	-0.56*	-0.32**	-0.73	-0.39	-0.44**
	(0.19)	(0.20)	(0.15)	(0.16)	(0.70)	(0.22)	(0.19)
Corrcont	0.04	0.32**	0.98*	0.60*	0.22	0.03	0.44**
	(0.06)	(0.15)	(0.30)	(0.12)	(0.38)	(0.07)	(0.16)
Law	0.08	0.18***	0.72	0.48**	1.16*	0.09	0.71
	(0.08)	(0.10)	(0.50)	(0.23)	(0.39)	(0.11)	(0.88)
Fiscdef	-0.30**	-0.07	-0.15***	-0.03	-0.10***	-0.34**	-0.04
	(0.15)	(0.16)	(0.08)	(0.11)	(0.06)	(0.14)	(0.10)
Findep	0.31	0.05	0.07	-0.09	0.14	0.30	0.29
	(0.34)	(0.40)	(0.19)	(0.21)	(0.20)	(0.27)	(0.44)
R-squared	0.41	0.15	0.49	0.20	0.68	0.32	0.26
Observations	260	130	134	156	91&	373	440
F-test	12.68	9.03	12.28	5.43	10.41	18.11	13.00

Note: All panel regressions include a country fixed effect. Robust standard errors are reported in parentheses. *, **, *** denote 1, 5 and 10% confidence levels. In all regressions a constant is included but not reported.

[4] We only report the results using the FE estimator. However, estimations using other estimators are also available upon request from the corresponding author.

In the first five regressions, we estimate the relationship in different regional economic groups of countries that include OECD-EU, Asian, Latin American and Caribbean, sub-Saharan and Post-socialist transition economies.[5] Finally, in regressions (6) and (7), we divide our dataset into two: countries above the median GDP per capita (titled Developed) and the ones below it (titled Developing).[6] Even though, the estimated coefficients of the terms are again as expected, we make a different observation here. The estimated coefficient of the squared term for the developing country subset is significantly larger in absolute value than the estimated coefficient of the linear term. In fact, this implies that, on average a larger informal economy is generally associated with higher growth in developed economies, whereas it is associated with a lower growth in developing ones.

Figures 1 and 2 aim to illustrate this sharp difference between these two country groups.[7] This is not surprising as there is generally a strong linear relationship between GDP per capita and informal sector size. That is, richer countries, ceteris paribus, tend to have a smaller informal sector. Therefore, considering the fact that informality is negatively associated with GDP per capita, we very much suspect that the inverted-U relationship between growth and informality, robustly established in the whole dataset might to some extent originate from this difference, namely that developed countries have low informality and developing countries have high informality. In the next section this will become clearer when we investigate the relationship between the three growth accounts and informal economy size.

[5] Countries in these groups are listed in the appendix. In addition to different country groupings, we had already experimented with different stratifications of our dataset, such as different corruption rankings, different rankings with respect to government spending etc. Using these rankings, we did not obtain a significant and robust relationship compared to the ones reported in the paper.

[6] Informality is a relatively bigger phenomenon for developing countries; this is reflected in the (especially micro-level) papers we review in the second section. However, this does not mean that informality is negligible for developed economies. For example, Elgin and Oztunali (2012) estimate that informal sector size is about 15% of GDP in OECD and EU economies.

[7] For these subsets, which to some extent control for GDP per capita, it is evident that there exists a significant linear relationship (albeit with different signs). However, when we draw the same relationship for the whole dataset then we do not observe a significant plain correlation. This might be due to the fact that the variation of the data is much more for the whole dataset than the subsets. That is why we actually have to rely on robust econometric analysis (not just look at the plain correlations) and that is why we run various regressions for the whole dataset in earlier sections of the paper. This analysis reveals that GDP per capita significantly interacts with the growth-informality relationship, similarly to what Figures 1 and 2 indicate.

Figure 1. Growth and informality: high-income countries

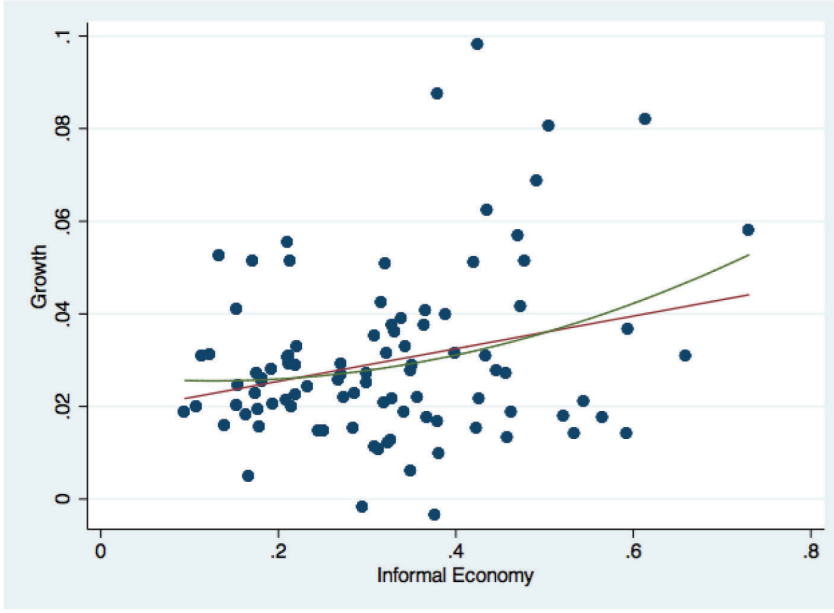
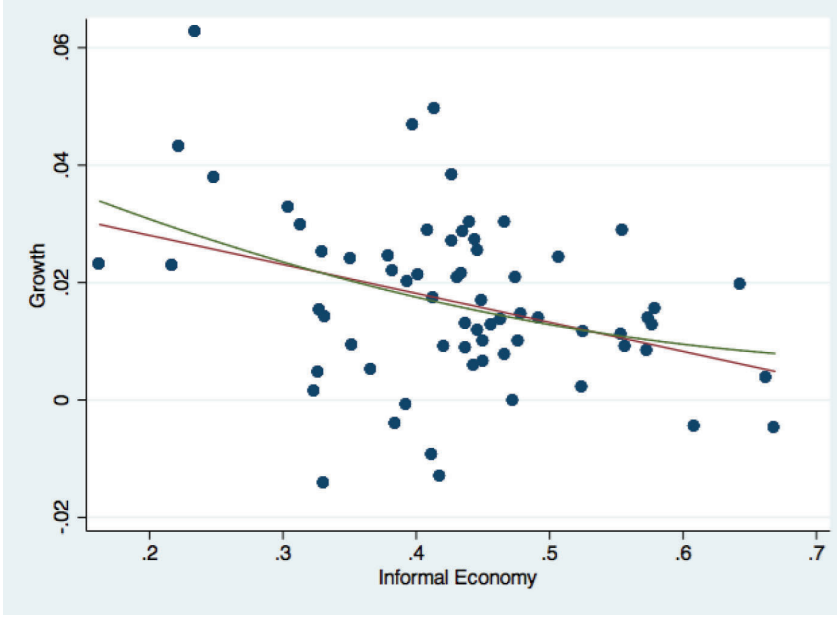


Figure 2. Growth and informality: low-income countries



V. Informality and growth accounts

The analysis in the previous section indicates that growth of GDP per capita has a non-linear relationship with informal sector size. Moreover, the sub-sample analysis we conducted reveals that the relationship between informal sector size and growth significantly interacts with the level of GDP per capita. In this section we take the analysis one step further and also investigate the relationship between informality and several growth accounts.

As well known, the growth account exercise dates back to Solow (1957) and aims to measure the contribution of different factors of production to growth. Here, we will present this exercise and then further develop it to understand how it might be linked to the presence of informality.

To conduct the growth accounting exercise using official national income statistics and find out how informality might be associated with different growth accounts, we use the basic Cobb-Douglas production function of the following form:

$$Y_{Ft} = A_{Ft} K_{Ft}^{\alpha} N_{Ft}^{1-\alpha}.$$

This function defines formal output at the end of year t, i.e., Y_{Ft} in terms of formal capital K_{Ft} and formal employment N_{Ft}.[8] A_{Ft} is the formal total factor productivity (TFP) and α is defined as the capital share of formal output. (Similarly, $1-\alpha$ is defined as the labor share of income.)

Dividing both sides of the previous equation by population N_{Ft}, we obtain formal output per capita y_{Ft}, which is given by:

$$\frac{Y_{Ft}}{N_t} = y_{Ft} = \frac{A_{Ft} K_{Ft}^{\alpha} N_{Ft}^{1-\alpha}}{N_t} = A_{Ft} k_{Ft}^{\alpha} n_{Ft}^{1-\alpha},$$

where k_{Ft} and n_{Ft} are per capita formal capital stock and employment. Next, taking the natural logarithm and manipulating the equation above, we obtain:

$$\ln(y_{Ft}) = \ln(n_{Ft}) + \frac{\alpha}{1-\alpha} \ln\left(\frac{k_{ft}}{y_{Ft}}\right) + \frac{1}{1-\alpha} \ln(A_{Ft}).$$

Considering that we have data on y_{Ft}, k_{Ft} and n_{Ft}, we can calculate A_{Ft} using this equation. What remains to be done is to create a series for k_{Ft} or K_{Ft}.We calculate

[8] We use the term "formal" to refer to the official statistics as opposed to the informal sector aggregates.

a K_{Ft} series using the perpetual inventory method using investment series from national income statistics.

As is well known, the perpetual inventory method uses the following two equations to construct the capital stock series:

$$\frac{K_{F0}}{Y_{F0}} = \frac{I/Y}{g_Y + \delta}, \text{ and } K_{Ft+1} = I_t + (1-\delta)K_{Ft},$$

where g_Y is the average growth rate of formal GDP, δ is the depreciation rate of physical capital, and I/Y is the average investment-to-GDP ratio in the period of interest. Moreover, the natural logarithm of formal GDP per capita can be written in growth terms as follows:

$$\ln(\frac{y_{Ft+1}}{y_{Ft}}) = \frac{1}{1-\alpha}(\ln(A_{Ft+1}) - \ln(A_{Ft})) + \frac{\alpha}{1-\alpha}(\ln(\frac{k_{ft+1}}{y_{Ft+1}}) - \ln(\frac{k_{ft}}{y_{Ft}}) + \ln(n_{Ft+1}) - \ln(n_{Ft}).$$

This equation decomposes the natural logarithm of the growth rate of formal GDP per capita into three different growth accounts: growth in formal TFP, growth in the formal capital-output ratio and growth in formal labor per capita.[9] In order to understand the effect of informality on growth of per capita income, one should separately analyze the former's effect on the three growth accounts emerging from the simple growth accounting. We do not have a definite a priori expectation on the estimated coefficient of growth in TFP; but considering that the informal sector is highly labor intensive compared to the formal sector, a negative coefficient of the growth in the capital-output ratio and in formal labor growth would not be surprising.

Therefore, we regress the three growth accounts separately on the informal sector size. We report the results of both FE and OLS regressions for growth in TFP, growth in the capital-output ratio and growth in the employment-population ratio in Table 6.

[9] This equation as well as our empirical estimations implicitly assumes that the GDP completely ignores informal sector estimates. However, we should recognize recent efforts by national statistical institutes to incorporate at least some estimates (if not all) of informality within the system of national accounts.

Table 6. Growth accounts and informality

	TFP				*K/Y*				*Lab*			
	FE	FE	OLS	OLS	FE	FE	OLS	OLS	FE	FE	OLS	OLS
IS	0.16*	0.31*	0.03*	0.05*	-0.23*	0.21*	-0.03*	0.21*	-0.04*	-0.07*	-0.02*	-0.02**
	(0.02)	(0.06)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.04)	(0.01)	(0.02)	(0.003)	(0.01)
IS2		-0.16***		0.002		-0.46*		-0.28*		0.03		0.005
		(0.10)		(0.004)		(0.08)		(0.05)		(0.03)		(0.01)
*IS*GDPpc*	0.01*	0.01*	0.003*	0.003*	0.01	-0.01***	0.001	-0.002	0.002	0.006	0.005	0.005
	(0.002)	(0.002)	(0.001)	(0.001)	(0.01)	(0.006)	(0.001)	(0.002)	(0.004)	(0.005)	(0.005)	(0.004)
Open	-0.002	-0.002	0.006*	0.006*	0.03*	0.02*	0.005***	0.003	-0.003*	-0.003*	0.002	0.002
	(0.004)	(0.005)	(0.002)	(0.002)	(0.01)	(0.006)	(0.002)	(0.03)	(0.001)	(0.001)	(0.002)	(0.002)
Govexp	-0.09*	-0.07**	-0.04*	-0.03**	-0.02	0.02	0.01	0.01	0.01	0.01	0.001	0.001
	(0.03)	(0.03)	(0.01)	(0.02)	(0.04)	(0.04)	(0.02)	(0.02)	(0.01)	(0.01)	(0.004)	(0.004)
GDPpc	-0.0005	-0.0005	-0.0003	-0.0003	0.001**	0.002*	-0.0005	0.0006**	0.002	0.001	-0.0004	-0.0004
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0005)	(0.0005)	(0.0003)	(0.002)	(0.001)	(0.007)	(0.0007)
Inf	0.01	0.01	0.002	0.003	-0.01**	-0.01**	-0.02***	-0.01	0.02	0.02	0.01	0.01
	(0.02)	(0.02)	(0.03)	-0.03	(0.004)	(0.004)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Corrcont	0.04	0.05	0.01	0.02	0.01	0.01	0.005	0.007	0.02	0.02	0.03	0.03
	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.02)	(0.01)	(0.04)	0.04)	(0.03)	(0.03)
Law	0.08**	0.09**	0.04***	0.04***	0.01	0.02	0.03***	0.03***	0.03	0.04	0.04	0.04
	(0.04)	(0.04)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.05)	(0.05)	(0.04)	(0.04)
Fiscdef	0.009	0.01	0.01	0.01	-0.04	-0.03	-0.02	-0.07	0.01	0.01	0.01	0.01
	(0.01)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)
Findep	0.01	0.01	0.02	0.01	-0.01	-0.01	0.01	0.01	-0.01	-0.02	-0.02	-0.02
	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)
R-squared	0.15	0.15	0.06	0.06	0.16	0.18	0.04	0.05	0.10	0.11	0.14	0.13
Observations	813	813	813	813	813	813	813	813	813	813	813	813
F-test	27.63	24.21	8.34	9.01	14.14	15.87	7.70	7.59	28.51	24.30	18.44	10.00

Note: All panel regressions include a country fixed effect. Robust standard errors are reported in parentheses. *, **, *** denote 1, 5 and 10% confidence levels. In all regressions a constant is included but not reported.

Our observations from Table 6 can be summarized as follows: a larger informal economy is associated with a larger growth in TFP and this association strongly interacts with GDP per capita. In other words, it is much stronger in richer countries as opposed to poorer ones. However, at the same time, a larger informal economy is also associated with a lower growth of the capital-output ratio and this association does not significantly interact with GDP per capita. Similarly, informal economy size is negatively correlated with growth in employment per capita without a significant interaction with GDP per capita. We believe that these results shed more light on the inverted-U relationship between growth and informal economy size. Accordingly, our results in Table 6 show that the difference in the relationship of informal sector size with growth between richer and poorer economies might arise from differences in informality's relationship with growth accounts in rich and poor economies. In other words, in developed (developing) economies, the positive relationship between informal sector size and TFP growth dominates (is dominated by) the negative relationships of growth of capital-output ratio and employment per capita with informal sector size. This might be the underlying cause of why the growth-informality relationship is different in developed and developing economies as well as why it is non-linear in the first place.

This result paves the way for future research and indicates that one should further examine the relationship between informality and total factor productivity and its interaction with GDP per capita.

VI. Concluding remarks

In this paper we explore the impact of the presence of informal (shadow) economies on long-run economic growth. Using a novel dataset we have shown that there is a robust inverted-U relationship between economic growth and informal economy size. Our results are further reinforced when we decompose growth into three components using a simple growth accounting framework, i. e. growth in total factor productivity (TFP), growth in capital-output ratio and growth in labor. We also find that the size of the informal economy is mainly associated with growth in TFP and this relationship very much interacts with GDP per capita. What is however missing in the current paper and we intend to study in the future is to identify the exact economic mechanism behind our observations. Future research should focus on developing economic models to further account for this observation. Developing an endogenous growth model extended with the presence of an informal sector would be the first step in this direction and that is what we leave for future research.

Appendix

A. Group compositions

OECD-EU: Australia, Austria, Belgium, Canada, Chile, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Korea (South), Luxemburg, Malta, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK, USA

Latin American and Caribbean: Argentina, Bahamas, Belize, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, Venezuela,

Post-Socialist: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, FYR Macedonia, Moldova, Mongolia, Poland, Romania, Russia, Slovakia, Slovenia, Tajikistan, Ukraine,

MENA: Algeria, Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, UAE, Yemen,

Sub-saharan Africa: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Democratic Republic of Congo, Republic of Congo, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Asia - Oceania: Bangladesh, Bhutan, Brunei, Cambodia, China, Comoros, Fiji, Hong Kong, India, Indonesia, Laos, Macao, Malaysia, Maldives, Nepal, Pakistan, Papua New Guinea, Philippines, Singapore, Solomon Islands, Sri Lanka, Taiwan, Thailand, Vietnam.

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