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Recent Trends of Informality in Greece: Evidence from Subnational Data

Larry Qiang Cui and Jiaxiong Yao

SIP/2024/009

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Prepared by Larry Qiang Cui and Jiaxiong Yao

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ABSTRACT: This paper explores the evolution of informality in Greece as it is widely considered one of the major structural impediments to fiscal capacity and sustainable growth. It finds that informality has dropped significantly in Greece in recent years, although there were temporary increases during the sovereign debt crisis and the COVID-19 pandemic. Lower informality is also found to be associated with higher subsequent per capita GDP growth and higher tax revenue. Moreover, Greece’s significant recent progress in digitalization appears to have helped reduce informality. There remains scope to further reduce informality by accelerating digitalization and the ongoing pro-growth structural reforms.

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SELECTED ISSUES PAPERS

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Greece

Prepared by Larry Qiang Cui and Jiaxiong Yao

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RECENT TRENDS OF INFORMALITY IN GREECE – EVIDENCE FROM SUBNATIONAL DATA¹

This paper explores the evolution of informality in Greece as it is widely considered one of the major structural impediments to fiscal capacity and sustainable growth. It finds that informality has dropped significantly in Greece in recent years, although there were temporary increases during the sovereign debt crisis and the COVID-19 pandemic. Lower informality is also found to be associated with higher subsequent per capita GDP growth and higher tax revenue. Moreover, Greece's significant recent progress in digitalization appears to have helped reduce informality. There remains scope to further reduce informality by accelerating digitalization and the ongoing pro-growth structural reforms.

A. Introduction

1. High levels of informality in Greece have been understood as a major structural impediment and a major target of reforms since the sovereign debt crisis. Widespread informality was considered to have impeded sustainable growth and fiscal capacity (e.g., McKinsey & Company (2012) and Oxfam (2013)). Therefore, the subsequent structural reforms also focused heavily on measures aimed at reducing informality and the associated tax evasion (e.g., European Commission (EC) (2014) and IMF (2017)). While the reform progress was more mixed in the previous years (Botman and Kalavrezou (2019)), more positive results have been achieved over time, including in labor market flexibility and the business environment, with improved implementation efforts by the authorities (EC(2023a) and OECD(2023)).

2. This paper uses some big data sources and other sub-national data in addition to conventional data used in the literature to analyze how informality has evolved in recent years to inform relevant policy discussions. Informality, or informal economy, discussed in this paper refers to economic activities not covered or insufficiently covered in formal arrangements. As in Alexander and others (2021), informality “comprises production of informal sector units, production of goods for own final use, production of domestic workers, and production generated by informal employment in formal enterprises.” Given the inherent difficulty to measure informality that is not covered in formal statistics and encounters reporting bias in surveys, we explore using conditionally independent indicators, including some big data sources, including satellite nightlight and google search, at the subnational level and the Multiple Indicators Multiple Causes (MIMIC) approach. In addition, we explore how digitalization efforts affect informality developments and draw on other recent studies to discuss policy implications.

¹ Excellent research assistance was provided by Shiqing Hua and Katherine Dai. This paper benefited from valuable comments from the Bank of Greece and the Ministry of Finance.

B. Literature Review

3. There is a large literature on estimating informality including for EU countries, albeit with varied definitions. In the literature, informality is known in varied names with overlapping coverages, such as “shadow economy” or “grey economy.” Some studies rely on micro survey data, while others use model estimations. For example, Elgin and Schneider (2016) studied levels and driving forces of informality in 38 OECD countries using both DGE and MIMIC approaches. Elgin and others (2019) used a large dataset to document that the share of the informal economy for advanced economies has declined to an average of 17 percent in 2016. In another cross-country study, Hu and Yao (2022) find that using satellite nightlight data, which are independent to economic statistics and survey data, can improve the estimates of true GDP per capita.

4. Several different approaches have been explored in estimating the size of the informal economy in Greece. Artavanis and others (2016) used micro data on household credits from a Greek bank and estimated that about 43-45 percent of self-employment income was not reported and thus not taxed. Also, Dellas and others (2017) at the Bank of Greece used a DSGE model and the actual fiscal consolidation measures to evaluate the role of the informal economy during 2010-15. They find that informality increased substantially from 25 percent of GDP to between 35 and 40 percent of GDP, which in turn affected the results of fiscal measures including missed revenue targets. In addition, Kelmanson and others (2019) estimated informality trend for European countries using MIMIC and reported that informality in Greece declined from 32 percent of GDP in 2009 to 30 percent of GDP in 2016. More recently, Schneider and Asllani (2022) provided updated estimates on the size of informality in the EU, showing that informality in Greece declined continuously from about 24 percent in 2013 to 19 percent in 2019 but edged up in 2020 and 2022. However, few studies have used sub-national data to study informality in Greece, while recent progress in available big data has offer better support to this approach as adopted in our paper.

5. Drawing on the recent literature, this paper adopts the MIMIC approach with improved data and estimation method. Medina and Schneider (2018) evaluated a range of methods used in estimating informality using data for 158 countries. They found that MIMIC method has advantages in implementation and provides plausible results as compared to other methods (e.g., micro survey, national account discrepancy approach, transaction approach, and currency demand approach), and using nightlight intensity data can further mitigate potential endogeneity bias. Therefore, we chose MIMIC in the estimation, added satellite nightlight and google searches to conventional data sources, and further improved the estimation method.

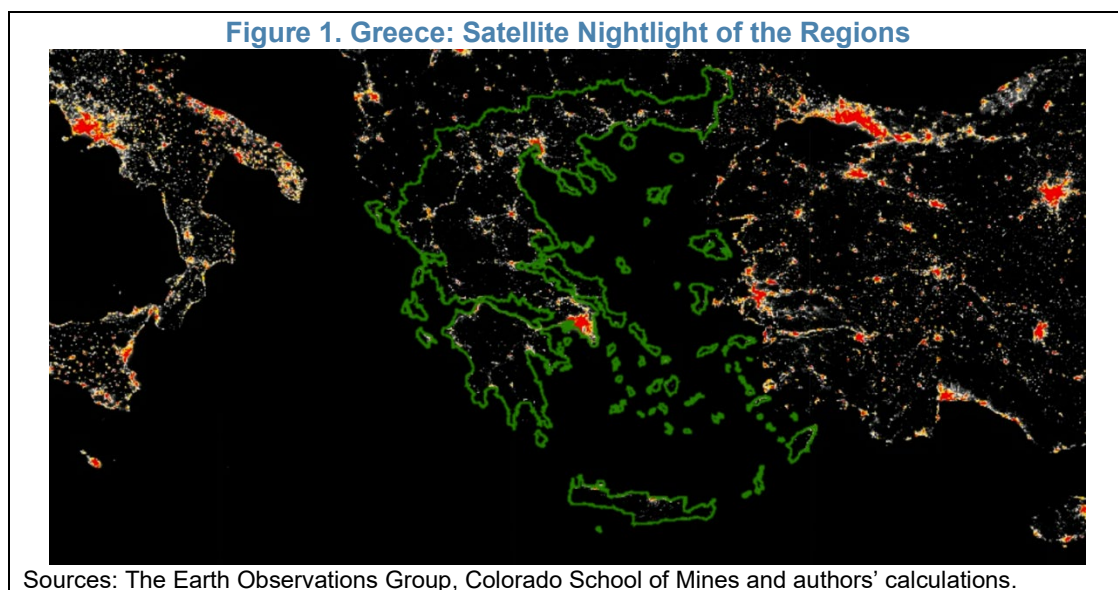
C. Methodology and Data

6. The MIMIC method links multiple observable indicators to multiple observable causes of the informal economy through a latent variable (Annex I). The latent variable is an index of the informal economy that can be used to calculate the size of the informal economy through variable transformation and calibration. First, it estimates the latent informality index by regression with restrictions through maximum-likelihood estimation. Next, World Bank (2018) Enterprise Survey

for Greece is used to calibrate the index to the survey data and relate the informality index to formal GDP statistics.

7. In addition to observable indicators used in the literature, we add satellite nighttime data and google search data at the subnational level for 2012–2021. These observable subnational data are in quarterly frequency and are more independent from formal national statistics or self-reported survey data to help mitigate potential biases. The use of subnational data also allows the analysis to focus on the variations in a shared institutional environment.

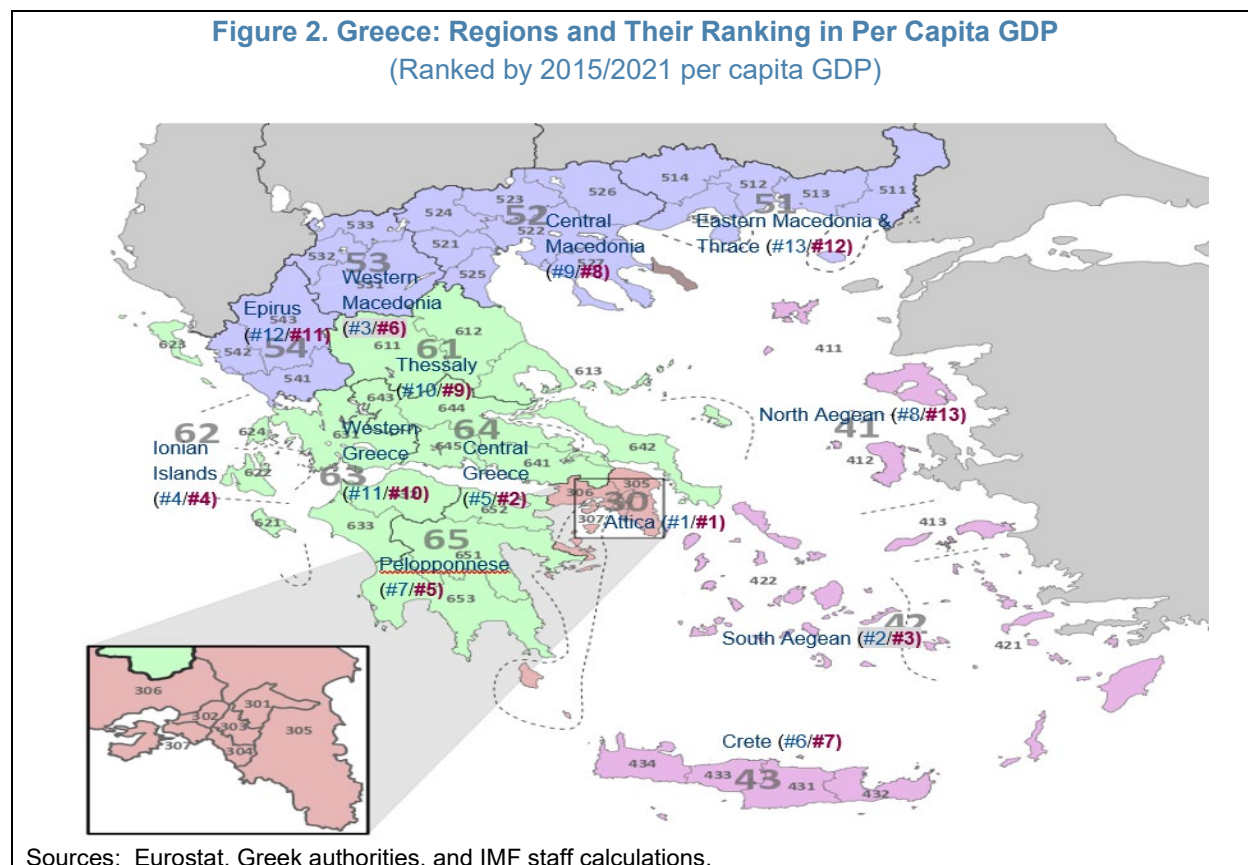
- *Satellite nighttime lights.* Satellite-recorded nighttime lights have been shown to be highly correlated with economic activity (see, for example, Henderson and others (2012), Hu and Yao (2022), Beyer and others (2022)). Following Beyer and others (2022), this paper uses the nighttime data from the Visible Infrared Imaging Radiometer Suite (VIIRS) Day on board of the latest generation of earth observation satellite. The sum of nighttime light intensity (radiance) within each region is used as a proxy for overall economic activity in that region (see Figure 1 for a snapshot illustration).



- *Google search.* Given the importance of tourism in Greece, google search data are also used as an independent source to proxy true tourism-related activities. Narita and Yin (2018) and Hu and others (2023) have shown that the search volume of a country name can be a useful indicator of economic activity of that country. This paper uses the search volume of the name of a subnational region as a proxy of economic activity in that region.
- *Other conventional variables in the literature including labor participation rate and GDP.* Labor participation rate and GDP are from Eurostat at NUTS 2 subnational level. Notice that due to population aging, the labor participation rate of the entire population could have a different trend from that of population aged 20-64. As the latter is most likely to participate in the informal economy, the activity rates for population aged 20-64 are used. Both labor participation rate and GDP are transformed into first differences as typically used in the MIMIC literature.

8. On causes, we used the conventional variables to reflect the underlying reasons that give rise to the informal economy. At the sub-national level, we include Eurostat data on agriculture employment as a share of total employment, self-employment as a share of total employment, unemployment rate, lagged income per capita, tourist arrivals as a share of total population, as well as education attainment. For education attainment, the share of population aged 25-64 with less than primary, primary, and lower secondary education is used, as less skilled labor tends to participate in the informal sector. At the national level, we also used macro variables related to the role of fiscal policy, trade, and governance: Value Added Tax (VAT) gap, tax as percent of GDP, trade openness, government consumption as percent of GDP, and World Bank governance indicators.

Figure 2. Greece: Regions and Their Ranking in Per Capita GDP
(Ranked by 2015/2021 per capita GDP)



9. For calibration, we used a World Bank Enterprise Survey for Greece in 2018, which is the most recent and publicly available survey with relevant information on informality. The survey classifies firms at NUTS 1 subnational level. As such, the size of the informal economy at each NUTS 1 region is calculated. Each NUTS 2 region is assumed to have the same level of informality as the NUTS 1 region that they belong to. The key source data are based on two questions closely related to the size of the informal economy:

- “Does this establishment compete against unregistered or informal firms?”
- “What is the number of permanent, full-time employees at the end of last fiscal year?”

The answers to these two questions are denoted by e and l , respectively, with $e=0$ indicating no competition with unregistered or informal firms and $e=1$ indicating competition with unregistered or informal firms. The number of employees in firms that are competing with informal firms in a region can then be computed as $\sum e_{kt}l_{kt}$, where k is a firm index in a region of interest. Assuming that each formal firm that competes with unregistered or informal firms has exactly one competitor with the same number of employees, one can calculate the size of the informal economy as follows:

$$z_t = \frac{\sum e_{kt}l_{kt}}{\sum e_{kt}l_{kt} + \sum l_{kt}}$$

The key stylized facts based on the 2018 enterprise survey are summarized below:

By Region		By Sector	
Northern Greece	15%	Food	27%
Central Greece	24%	Fabricated Metal Products	17%
Attica	20%	Other Manufacturing	13%
Aegean Islands	25%	Retail	29%
		Other Services	19%

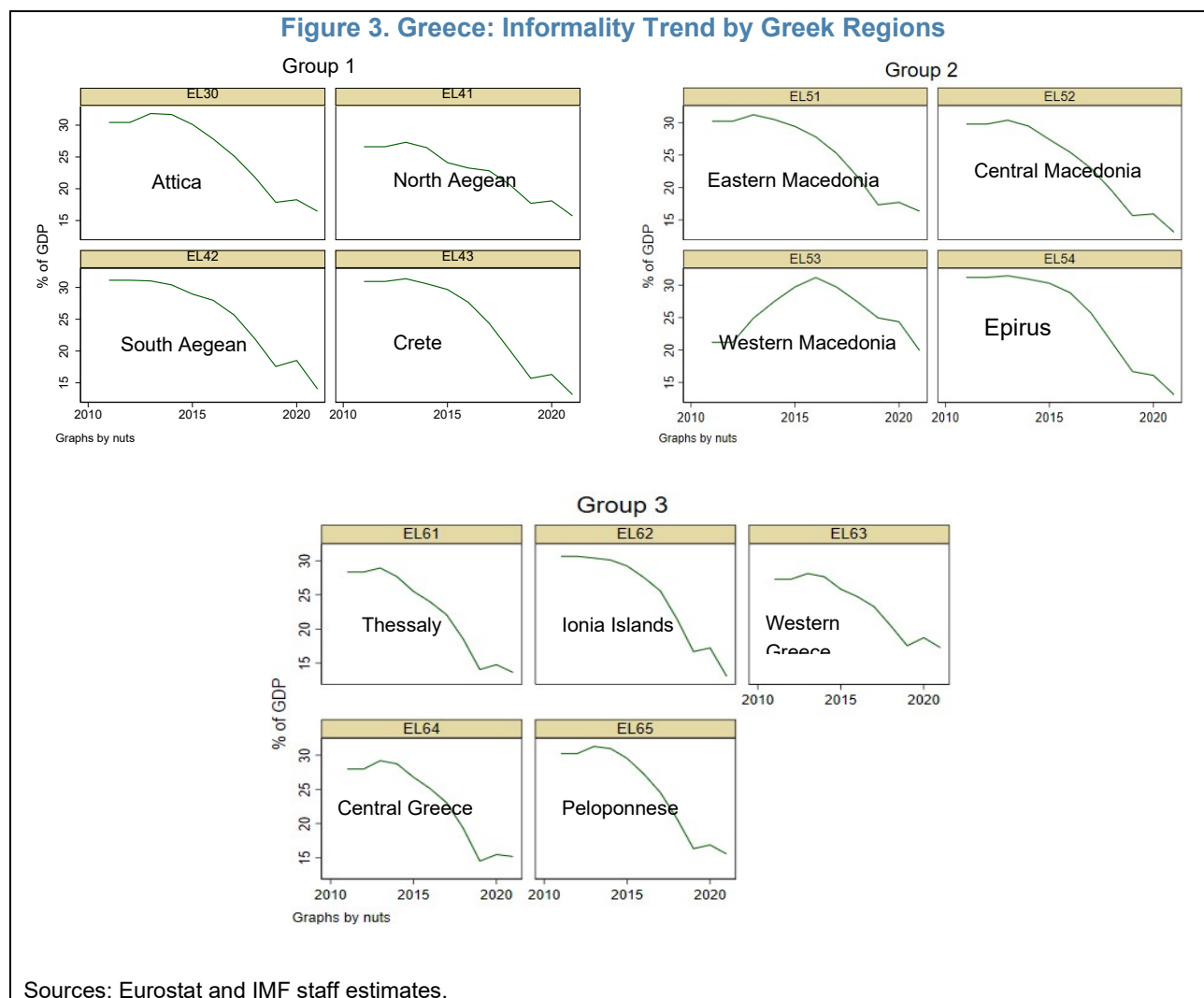
Sources: The World Bank Enterprise Survey (2018) and authors' calculations.

D. Main Findings

10. The estimates show that informality has dropped significantly in all regions in the past decade, notwithstanding some brief increases around 2013-15 and 2020 (Figure 3). During the sovereign debt crisis periods, most regions experienced increased informality by an average of 0.6 percentage point for informality to peak at about 30 percent of GDP at the national level. The results are consistent with earlier findings by Dellas and others (2017), although their estimated increase was larger.¹ Our informality level estimates for this period are more in line with Kelmanson and others (2019) and Schneider and Asllani (2022). The significant increase can be attributed to the severe recession, worsened tax incentives from significant fiscal tightening, and a further weakening of the payment culture with decreased trust in government (Botman and Kalavrezou (2019) and Oxfam (2013)). In comparison, most regions had relatively small increases in informality during the peak pandemic year of 2020 and continued declines in 2021. These increases could be attributed to slower output declines in the informal sector than in the formal sector that is less flexible and more vulnerable to pandemic-related disruptions, similar to what was reported in Elgin and others (2022) and Schneider and Asllani (2022). However, significant government support in Greece during the pandemic likely cushioned the impact and thus moderated the increase in informality compared to previous recessions. In addition, there are also significant variations in the size of informality declines among the regions, ranging from 5 percent of GDP (Western Macedonia) to 18 percent of

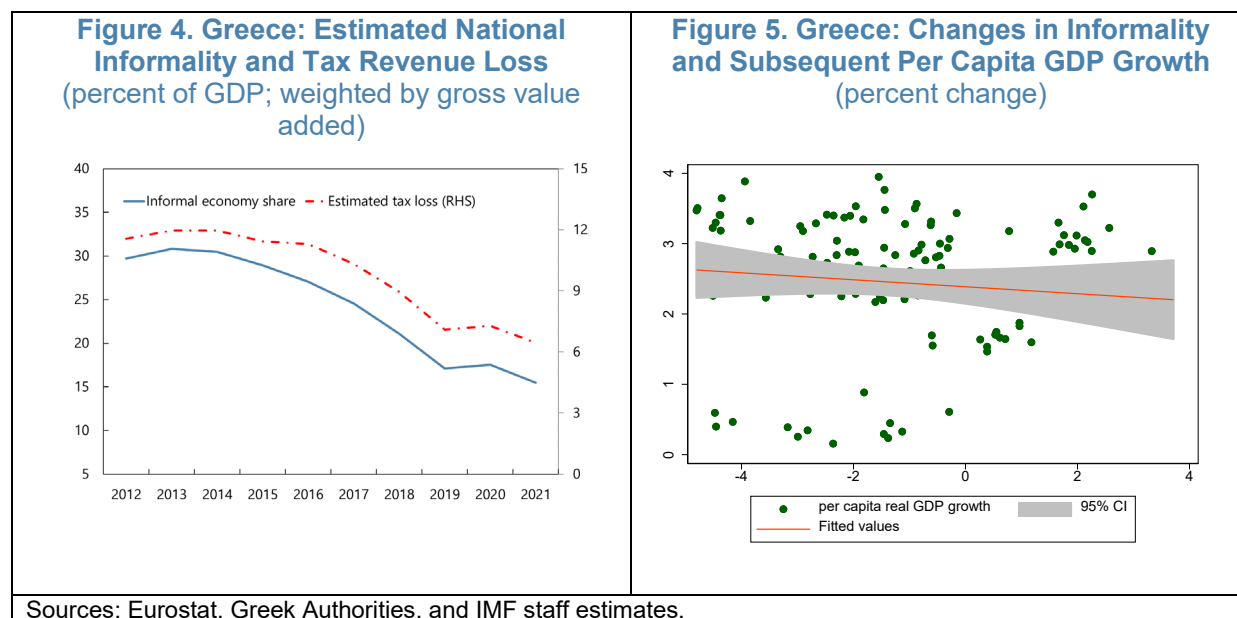
¹ Hondroyannis and Papaoikonomou (2017) and IOBE(2018) noted that Greece imposed capital controls that led to a significant increase in card and digital payments that reduced informal payments. To the extent that this presented a structural break, the estimation calibrated using 2018 firm survey data could underestimate the earlier increases in informality during the crisis period.

GDP (Crete). In general, the drops are more significant at above 15 percent of GDP in Attica and the island regions (e.g., Crete and Ionia Islands). In contrast, the more inland region of Western Macedonia experienced higher increases in informality around the sovereign crisis episode followed by a more moderate decline. Similarly, Western Greece saw a smaller decline at about 10 percent of GDP. While the progress in digitalization could explain some of the differences, future research is needed to better understand the drivers of the subnational variations.



11. Also, the estimated reductions in informality are associated with positive economic benefits, including lower tax revenue loss and higher subsequent per capita GDP growth. At the national level, the aggregate informality, weighted by regional gross value added, recorded a decline from a peak of about 30 percent of GDP in 2013 to a low of about 16 percent of GDP in 2021 (Figure 4). Using the buoyancy of the total tax revenue (direct, indirect taxes and social security contributions) to GDP in these years, such a decline in informality is associated with a gain in tax

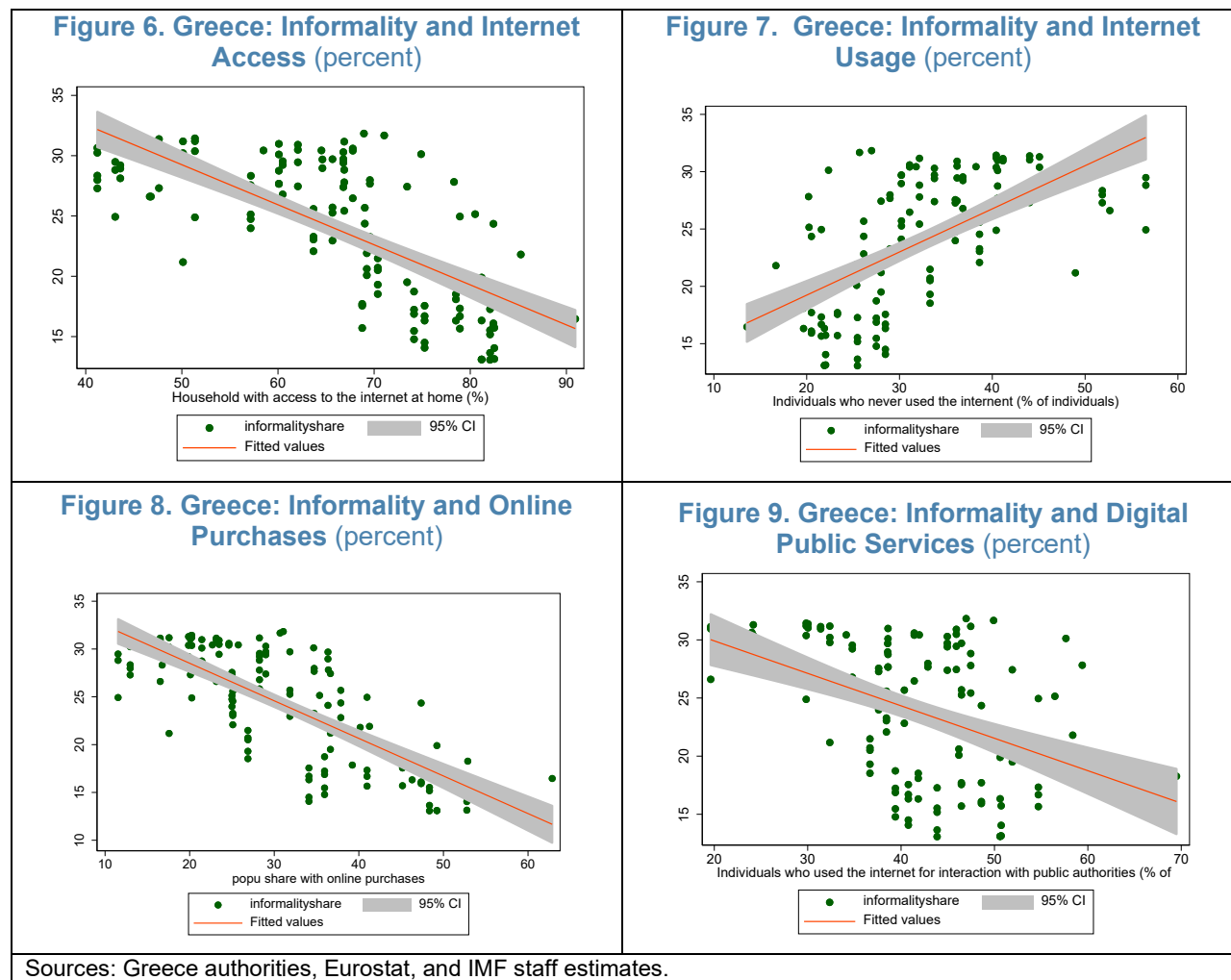
revenue by about 4 percentage points of GDP.² While this estimate is more of a potential tax increase, its magnitude is broadly consistent with recent reports on improved tax collections in Greece. For example, EC (2015 and 2023c) find that Greece's Value Added Tax gap has decreased by over 16 percentage point of its tax base between 2013 and 2021, or about 2 percentage points of GDP. In addition, the correlation of changes in informality and subsequent per capita GDP growth shows that lower informality is associated with higher subsequent growth, also highlighting the output benefits (Figure 5).



12. Furthermore, regional-level correlations show that digital infrastructure and its usages have a strong impact on informality in Greece. Better digitalization indicators show consistent negative correlations with the share of the informal economy at the regional level. First, a 10-percentage point increase in internet access is on average associated with a reduction of informality by about 3 percentage point (Figure 6). Second, a 10-percentage point reduction in the share of residents who have never used internet is associated with a reduction in informality by about 4 percentage points (Figure 7). Third, a 10percentage point increase in the share of residents who used online purchase is associated with a reduction in informality by about 4 percentage points. This is consistent with earlier findings that digital payments reduced informality and tax evasion (IOBE(2018); Hondroyannis and Papaoikonomou (2017)). Fourth, a 10-percentage point increase in the share of residents who used digital public services online purchase is associated with a reduction in informality by about 3 percentage points. While noting the limits in correlation analysis, these results taken together do suggest positive effects of digital infrastructure expansion, digital training, and digital public services. The results also corroborate other recent reports that pointed out digitalization as a major factor that helped reduce informality in Greece. OECD (2023) pointed out that increased digital transactions raised tax compliance in Greece. While starting from a relatively

² Given the lack of regional data on tax collections, the tax loss estimate is based on national level tax collection and buoyancy in the respective years.

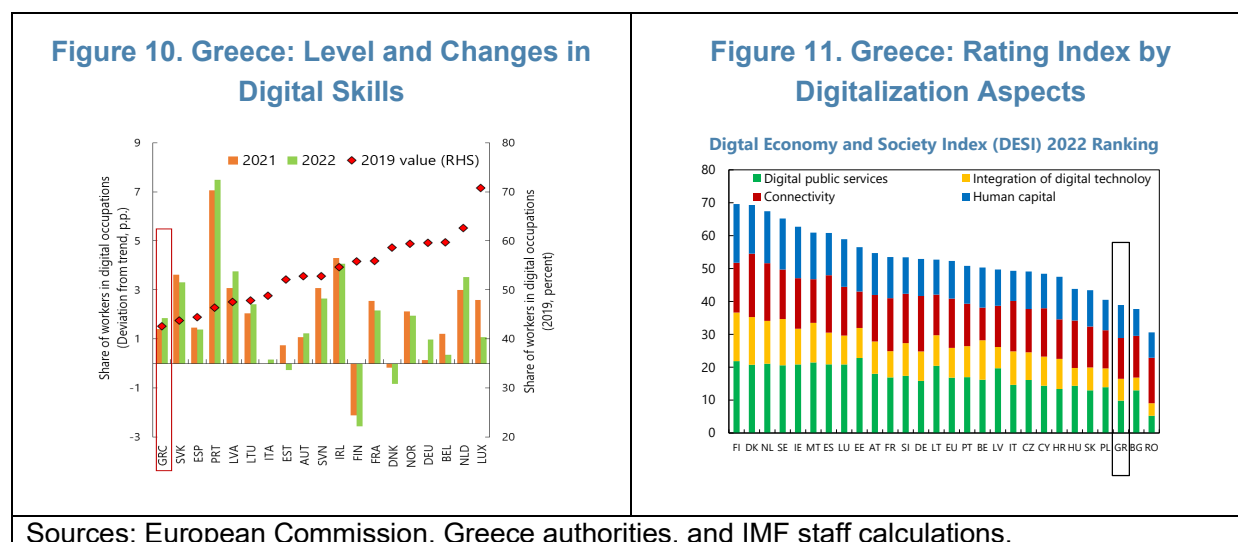
low level, Greece did make strong progress in digitalization in recent years (EC (2023b), Jaumotte and others (2023)), which in turn likely contributed to the significant reduction in informality.



13. Our study presents a first attempt of using sub-national data and big data in estimating the size of informality in Greece, but several caveats should be noted including for future research. First, if the relations between the variables (including satellite nightlight intensity or google search) and formal and informal economies activities show significantly diverging trend over time, such effects are not well controlled in the estimation. Future research with better calibration using more available data on Greece firm surveys, for example, could refine the estimation. Second, the analysis is also constrained by the lack of availability of more relevant subnational data, such as non-cash transactions, to establish tighter link with regional economic activities. Third, the impact of the social structure of the Greek regions could also have strong effects on informality and requires future research outside of the scope of this paper.

E. Policy Discussions

14. The significant decline in informality in recent years benefits from several policy factors. The tightened regulation and enforcement against financial crimes and tax evasion in Greece likely contributed to reducing informality EC (2023a), Schneider and Asllani (2022), and OECD (2023). Also, increased labor market flexibilities, such as in working hours, increased incentives for informal activities to become formal while keeping similar flexibilities. Significant progress in digitalization, including in improving infrastructure and improving digital public services, also supported progress in improving tax morale and integrating the self-employed (Medina and Schneider (2018) and Schneider and Asllani (2022)). Meanwhile, the modernized employment information system also eased the burden of registration while increasing monitoring that incentivized compliance. Another related factor for higher tax morale could be related to policy continuity with political stability and reduced corruption, consistent with arguments on the institutional drivers of informality Devine (2021) and Ohnsorge and Yu (2022). Furthermore, some rationalization of Greece’s tax policies in recent years, such as reducing business income tax rates and marginal personal income tax, likely helped reduce the incentive for tax evasion Schneider and Asllani (2022).



15. There is still strong potential for further strengthening digitalization to address remaining gaps and support reducing informality. While Greece recorded above average increase in digital skills (Figure 10), the corresponding level is still on the low end among euro area peers, showing strong potential for further improvement EC (2023b). In addition, there are remaining gaps in some aspects of digitalization, such as the integration of digital technology and in digital public services particularly for Small and Mediums Enterprises, that require continued efforts to incentivize formal activities (Figure 11). For example, more integrated information systems can enhance monitoring of tax compliance, ease business and employment registration and access to related public services, and better integrate the self-employed into the formal economy. Furthermore, the strong emphasis on digitalization and related skill training in the authorities’ National Resilience and Recovery Plan supported by the Next General EU funding also offers a strong promise for additional progress in the coming years.

16. Moreover, cross-country studies underscore the importance of other structural reforms to further reduce informality. Improving regulatory quality and transparency would ease the burden for business entry and support more productive competition OECD (2023), Medina and Schneider (2018), Ohnsorge and Yu (2022), and Schneider and Asllani (2022). In addition, increasing the efficiency in spending on education and training would also increase industry-relevant skills, job matching, and the incentive for formal employment Kelmanson and others (2019). Other related measures include more targeted employment support, such as for youth and women who still face a disproportionately elevated unemployment rates in Greece. Furthermore, reforms to better link firm and job formalization with access to finance can enhance the incentive to formalize Ohnsorge and Yu (2022). Finally, the relatively high level of self-employment in Greece warrants more concerted efforts to ensure that the corresponding activities are appropriately integrated in the formal economy Schneider and Asllani (2022).

Appendix I. Description of the Multiple Indicator Multiple Cause Model

The Multiple Indicator Multiple Cause (MIMIC) model is the prevailing modeling approach in the literature to estimate the size of the informal economy. It links multiple observable indicators of the informal economy to multiple observable causes of the informal economy through a latent variable. The latent variable is an index of the informal economy that can be used to calculate the size of the informal economy through variable transformation and calibration.

The MIMIC Model

The MIMIC model consists of a structural equation and a measurement equation. Let y_t^* be the latent index of the informal economy, which is assumed to be determined by a $q \times 1$ vector of causes $x_t = (x_{1t}, \dots, x_{qt})'$ through a linear structural equation:

$$y_t^* = \alpha' x_t + \eta_t,$$

where η_t is a structural disturbance that captures the component of the informal economy not explained by the causes x_t . Let $y_t = (y_{1t}, \dots, y_{pt})'$ be a $p \times 1$ vector of linear indicators of the latent index of the informal economy. The measurement model follows:

$$y_t = \beta y_t^* + \epsilon_t.$$

The disturbances are assumed to be mutually independent:

$$E(\eta_t \epsilon_t') = 0', E(\eta_t^2) = \sigma^2, E(\epsilon_t \epsilon_t') = \Theta^2.$$

The reduced-form equation of the MIMIC model is then:

$$y_t = \beta \alpha' x_t + (\beta \eta_t + \epsilon_t).$$

In essence, the MIMIC model is therefore a regression equation of y_t on x_t with two restrictions. First, the coefficient matrix before x_t , i.e., $\Pi = \beta \alpha'$, has rank one. Second, the covariance matrix of the error term is the sum of a rank-one matrix and a diagonal matrix $\Omega = E[(\beta \eta_t + \epsilon_t)(\beta \eta_t + \epsilon_t)'] = \sigma^2 \beta \beta' + \Theta^2$.

Note that if α and σ are multiplied by a scalar and β is divided by the same scalar, the reduced-form equation remains unchanged. As such a normalization is needed in order to pin down α and y^* . As with the practice in the literature, it is assumed that the first indicator has the same unit as y^* . In other words,

$$y_{1t} = y_t^* + \epsilon_{1t}.$$

The MIMIC model can be estimated by the maximum-likelihood estimation.

Data Transformation

As the analysis uses data at the subnational level, indicators and causes might vary only slightly across regions within a country but significantly across countries. To account for institutional and cultural differences, country fixed effects should be added in the analysis. To this end, all variables are demeaned at the country level. For example, the i th indicator y_{ijt} of country j at time t is transformed to $y_{ijt} - \bar{y}_{ij}$, where \bar{y}_{ij} is the average of the i th indicator for country j over all time periods. The same transformation is applied to the cause variables.

From Index to Size of the Informal Economy

Once α is estimated as $\hat{\alpha}$, the index of the informal economy can be calculated as $\widehat{y}_t^* = \hat{\alpha}' x_t$. \widehat{y}_t^* has the same unit as y_{1t} due to the normalization discussed above. However, the unit of y_{1t} , either as percentage point or percent change, does not always imply that this should be interpreted as the size of the informal economy, rescaling of \widehat{y}_t^* is therefore also needed. Moreover, because of recentering of indicator and cause variables, \widehat{y}_t^* needs to be re-calibrated to match the correct size of the informal economy at one point in time or on average.

Let z_t be the size of the informal economy. Assume \widehat{y}_t^* has a unit of percentage point. Then the level index of the informal economy $s_t = \sum_1^t \widehat{y}_t^*$. Suppose at two points in time the size of the informal economy is known, i.e., z_{t1}, z_{t2} are known. The size of the informal economy can be calibrated as

$$z_t = \lambda s_t + \delta,$$

where

$$\lambda = \frac{z_{t2} - z_{t1}}{s_{t2} - s_{t1}} = \frac{z_{t2} - z_{t1}}{\sum_{t1}^{t2} \widehat{y}_t^*},$$

and

$$\delta = z_{t1} - \lambda s_{t1}.$$

With more data points on the size of the informal economy, λ and δ can be estimated through an Ordinary Least Squares regression.

Appendix II. Details on MIMIC Results

Appendix II. Table 1. Greece: MIMIC Estimation Results

Structural				
	coefficient	std.err.	z	p-value
Informal agriculture employment share (%)	0.47	0.12	4.02	0.00
self employment share (%)	0.16	0.11	1.51	0.13
unemployment rate (%)	0.27	0.08	3.42	0.00
tourist arrivals as mutiple of population	-0.01	0.00	-6.24	0.00
(lagged) GDP per capita	0.32	0.03	10.63	0.00
population aged 25-64 with secondary education or lower (%)	-0.67	0.09	-7.90	0.00
VAT gap	0.59	0.05	11.74	0.00
tax (% of GDP)	-2.16	0.32	-6.74	0.00
trade openness	-0.46	0.05	-9.35	0.00
government consumption (% of GDP)	1.14	0.25	4.52	0.00
rule of law	-0.08	0.02	-3.76	0.00
control of corruption	0.02	0.02	1.31	0.19
government effectiveness	-0.03	0.02	-1.35	0.18
political stability	0.16	0.02	7.74	0.00
Measurement				
(-) GDP growth				
Informal		1 (constrained)		
labor participation rate growth				
Informal	-0.14	0.01	-9.79	0.00
Google Search Volume growth				
Informal	-0.13	0.53	-0.24	0.81
Nighttime light growth				
Informal	-0.07	0.10	-0.73	0.47

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