Rethinking the Informal Economy and the Hugo Effect*

Francesco Pappadà Kenneth S. Rogoff

November 11, 2024

Abstract

This paper offers a new approach to measuring the size of the informal economy based on VAT data for the European Union. Although data intensive, our *EVADE* measure is simpler and more transparent than existing measures. *EVADE* also shows more variation across countries of Europe than earlier measures, including higher informality in Greece, Italy and Spain, for example. Moreover, we find considerably higher variation within countries across time; in a cross-country time series regression, controlling for tax rates, we confirm that the informal economy grows significantly in recessions and decreases in booms, which we term the "Hugo effect".

JEL: E26, E32, H26, O17.

Keywords: Informal Economy, Business Cycles, Growth, VAT compliance.

*Pappadà: Department of Economics, Ca' Foscari University of Venice and Paris School of Economics. francesco.pappada@unive.it. Rogoff: Economics Department, Harvard University, Cambridge MA 02140 USA. krogoff@harvard.edu. We thank the editor, Guido Lorenzoni, one anonymous referee, Pierfrancesco Mei, Franziska Ohnsorge, Friedrich Schneider, Yanos Zylberberg and seminar participants at EUTAX Observatory at PSE, Bank of Portugal, Aix-Marseille School of Economics, CREST (Ecole Polytechnique) and SED 2024 (Barcelona) for useful comments. We are also grateful to Bayram Cakir for excellent research assistance. The usual disclaimer applies.

1 Introduction

There are few macroeconomic problems in Europe more important, or more vexing, than the size and scale of the informal economy which is believed to differ widely across countries within the European Union.[1] Since tax evasion is by far the most important driver of informality in developed and middle-income countries, it is obviously important for fiscal policy and a broad range of public finance issues, for example, horizontal fairness in taxation, debt sustainability and national income metrics which are important across a host of EU policies. But given that in some major countries the size of the informal sector appears to be over 20% of GDP (albeit there is high uncertainty), having better measures can also be important for monetary policy, particularly if the share of GDP is fluctuating significantly over the business cycle (with official statistics overestimating the size of employment and growth fluctuations).

Here we develop new annual estimates of the size of the informal economy across the countries of the European Union. To the best of our knowledge, this is the first attempt at translating a measure of VAT compliance into an aggregate measure of the informal economy. We make use of the fact that national statistics are collected on a relatively standardized basis, and that payment of VAT taxes is required across a very large fraction of private goods and services. Our measure of the informal economy uses detailed national account data and separately compiled VAT tax data, allowing us to estimate VAT tax evasion much more precisely both across countries and across time. In turn, VAT evasion reflects the share of Gross Value Added which is not reported to tax authorities. Using the Output Approach to compute GDP, we can impute the overall share of GDP which belongs to the informal economy, and define our measure as the Evading Value Added Duty Economy (henceforth *EVADE*). Compared to existing estimates, our new measure – although data intensive – is perhaps simpler and more transparent, which should potentially make it useful to both policymakers and researchers.

One way in which our estimates are particularly distinct from previous measures of the size of the informal economy is that they reveal significant differences across time within individual countries, with regression evidence suggesting that the informal sector is countercyclical: the informal economy grows significantly in recessions and decreases in booms. This point, in itself, is not new.[2] Indeed, in Les Misérables (1862), Victor Hugo wrote:

> *This never deceives. When the population suffers, when work is lacking, when the trade is nil, the taxpayer resists the tax by shortage, exhausts and exceeds the deadlines, and the State spends a lot of money in duress and enforcement fees. When work abounds, when the country is happy and rich, the tax is easily paid and costs little to the State.*

[1] National statistics in many (but not all) countries do attempt to impute informal activity and include it in national accounts, but the methods are widely varying, often opaque, and therefore, extremely difficult to extract from national accounts data, much less compare across countries.

[2] Andreoni (1992) develops a model where due to borrowing constraints, optimal tax enforcement can be procyclical. More recently, a number of empirical papers have focused on aspects of the problem, see Durán-Cabré et al. (2020), Horvath and Yang (2022) and Granda-Carvajal and García-Callejas (2023).

We can say that public misery and wealth have a thermometer infallible, the cost of tax collection.[3]

However, previous efforts to assess the overall size of the informal economy have lacked sufficiently high frequency data to detect the "Hugo effect". It is well known that VAT tax evasion is rampant, with official statistics showing large "tax gaps" between taxes that ought to have been collected according to national income statistics, and taxes actually collected according to tax authorities. Official estimates of European Commission (2020a) for 2018 range from 1.3% in Finland, 1.8% in Estonia and 2% in Sweden, to 20.8% in Italy, 24.1% in Malta and 35.7% in Romania (shares of total VAT revenues). A small percentage of the gap is due to bankruptcies, and to statistical errors, but by far the lion's share is due to deliberate evasion. Our measure of the informal economy takes into account the fact that some goods are taxed at special lower rates (and therefore the shortfall is not evasion), and that enforcement of the VAT tax on imports is far easier to impose. We also note that exports are not subject to VAT tax, whereas the enforcement of VAT rates on imports is larger due to border controls. Our measure of the informal economy improves the official estimates of the size of the underground economy along these dimensions, and can therefore be used to compare across countries with very different trade compositions and choices of politically favored consumption goods.

We do not by any means view our work as supplanting earlier estimates, but as providing a useful new perspective. The most prominent earlier estimates are from the seminal work of Schneider (for example, Enste and Schneider (2000); Schneider et al. (2010); Medina and Schneider (2018)). The MIMIC approach makes use of a wide variety data to impute underground activity at a point in time, but the results are difficult to compare across countries, typically only provide detailed estimates for short sample years, and in any event requires assuming the share of the underground economy in a base year to implement. The other major alternative, which uses general equilibrium DSGE models, is even more country specific, and relies on a number of strong assumptions, for example specific functional forms for demand. The World Bank (Elgin et al. (2021)) has recently surveyed and synthesized the existing literature, finding that in 2018, the share of informal output averages 17.4% in advanced economies and 31.7% in developing economies and emerging markets.

Overall, our empirical estimates of the scale of the informal economy in Europe differ from the existing literature in two major ways. First, they tend to be somewhat smaller for most European countries, including both relatively high income countries (e.g. Sweden, Ireland, Belgium) as well as some lower-income countries (Croatia, Latvia, Hungary and Bulgaria) with the informal economy in several countries being below 10% of official GDP. However, there are some notable exceptions, including Italy, Spain, Greece and Portugal, where the World Bank measure already

[3] *"Ceci ne trompe jamais. Quand la population souffre, quand le travail manque, quand le commerce est nul, le contribuable résiste l'impôt par pénurie, épuise et dépasse les délais, et l'Etat dépense beaucoup d'argent en frais de contrainte et de rentrée. Quand le travail abonde, quand le pays est heureux et riche, l'impôt se paye aisément et coûte peu à l'Etat. On peut dire que la misère et la richesse publiques ont un thermomètre infaillible, les frais de perception de l'impôt."* Les Misérables (1862), Volume 1, Book 5, Chapter 7.

has the informal economy at 20% of GDP or greater, whereas *EVADE* is nearer to 30% of GDP, with Greece at 36% of GDP. Second, and most importantly, *EVADE* is more volatile than alternative measures of informality, and this volatility is related to the state of the business cycle.

Using a cross-section time series panel regression, we explore the nature of the pronounced cyclicality of our *EVADE* measure. First, we find that variations in the unemployment rate – which is not used in any way in calculating *EVADE* – turn out to be extremely highly correlated with *EVADE*, controlling for variation in tax rates among other variables. Second, we analyze the countercyclical properties of *EVADE*, which we term the "Hugo effect", as we instrument the growth rate of GDP by the global financial cycle in Miranda-Agrippino and Rey (2020). We find that a 1% increase in the growth rate of GDP, instrumented by the global financial cycle, produces a drop in the size of the informal economy of about 40 basis points. With alternative measures of informality, which are relatively constant over the cycle, the effect is much smaller and typically not significant.

The remainder of the paper is organized as follows. In Section 2, we overview the existing measures of informality in the literature. Section 3 introduces our methodology to build a novel measure of the informal economy based on VAT compliance, Evading Value Added Duty Economy (*EVADE*). Section 4 reports summary statistics of *EVADE* and discusses the key differences with existing estimates of informality. Section 5 presents our main empirical results about the "Hugo effect". We show that *EVADE* is countercyclical, since it is sensitive to the unemployment rate and the growth rate of GDP that we instrument by the global financial cycle as in Miranda-Agrippino and Rey (2020). Section 6 briefly concludes.

2 Measures of informality

The informal economy, also known as the shadow or underground economy, has garnered significant attention in economic literature due to its pervasive presence which is detrimental for development and growth.[4] In what follows, we first briefly survey the existing literature on informality, stressing the implications of the dynamics of informal economy. We then discuss the major benefits and flaws of two indirect measures of informality, and explain why there is a need for a more transparent measure of the informal economy.

The size of the informal economy has been shown to be persistent due to the interaction of tax declarations with other frictional processes for businesses [e.g., consumer search or search for intermediaries, see Pomeranz (2015), dynamic incentives built within the tax monitoring system Engel and Hines (1999), the adjustment of the private sector to a general culture of informality

[4]The distinction between the underground economy (which includes the illegal activity) and the shadow economy (which does not) is a difficult line to draw firmly in practice if one includes regulatory evasion and, in any event, is not important here.

[e.g., through bank loans, see Artavanis et al. (2016)].[5] Enste and Schneider (2000) underscore the challenges posed by informality, including poor governance, limited access to finance, lower productivity, and higher income inequality. Additionally, Ohnsorge and Yu (2021) highlights the negative effects of informality, particularly in the context of the COVID-19 pandemic. Informal workers and firms were severely affected by lockdowns, exacerbating the challenges faced by the informal sector. The paper stresses the need for comprehensive policy measures tailored to country-specific circumstances to address informality effectively. Turning to the long-term dynamics of informality, Loayza (2016) examines how informality changes in size and type, and highlights the role of biased policies in contributing to informality, emphasizing the relationship between informality, labor migration, and economic growth.

Informality has a straightforward relationship with public finances and fiscal policy. As higher taxes lead to an expansion of the informal sector, the reallocation of the economy away from taxable activity may affect fiscal revenues in the short run, a static distortion shown in Aruoba (2021). These adjustments might persistently lower returns to taxation - a dynamic distortion - and increase concerns about debt sustainability and default risk as in Pappadà and Zylberberg (2023). This also relates to the literature discussing tax evasion and its dynamics during recent debt crises (see Pappa et al. (2015), Dellas et al. (2017)). In Pappa et al. (2015), higher taxes increase incentives to produce in the (less productive) informal sector. This mechanism explains the failure of the recent consolidation plans in Greece, Italy, Portugal and Spain. These observations, also exploited in Dellas et al. (2017), may help rationalize differences in estimates of fiscal multipliers across environments and fiscal policy tools (see Alesina and Ardagna (2009), Romer and Romer (2010), Favero et al. (2011), Auerbach and Gorodnichenko (2012), Alesina et al. (2015)).

While there is extensive evidence about the implications of informality on the overall functioning of an economy, there is much less clear evidence about the size of the informal economy.[6] Elgin et al. (2021) provides a comprehensive database of estimates for informal economic activity. It highlights the significance of self-employment and perceptions in cross-country analyses, while emphasizing the need for further research to improve the quality of informality measures. Indeed, institutions like WDI, ILO and OECD provide *direct* measures of informality based on labor-force surveys that look at the share of self-employment, as well as informal employment and employment outside the formal sector. These estimates of informality rely on firm or worker surveys that have limited year coverage. A different approach is to estimate the unobserved informal economy by exploiting the difference between the official statistics on GDP and energy consumption. Restrepo-Echavarria (2014) investigates the relationship between informality and macroeconomic volatility. The findings indicate that countries with larger informal sectors expe-

[5] From a theoretical point of view, La Porta and Shleifer (2014) supports the dual view of informality, highlighting the persistently informal nature of informal firms and the limited benefits they derive from formalization. The authors argue that economic growth is the key driver for reducing informality.

[6] Medina and Schneider (2018) provides a comprehensive overview of shadow economies worldwide over the past 20 years. Their paper presents various methods of estimating the size of the shadow economy and emphasizes the importance of multiple estimation approaches. It also highlights the declining trend in the size of the shadow economy, albeit with temporary interruptions.

rience higher volatility in cyclical consumption relative to output. This suggests that the presence of a poorly measured informal sector contributes to higher consumption volatility.

In a recent study, Elgin et al. (2021), the World Bank highlights two *indirect* measures of the informal economy: the Multiple Indicators Multiple Causes (MIMIC) model introduced by Schneider et al. (2010), and the DGE model of Elgin and Oztunali (2012). In a recent contribution, Schneider and Asllani (2022) examines the taxation of the informal economy in the EU using a MIMIC approach. The findings reveal a strong increase in the shadow economy, attributed to the global recession and energy shortages. Moreover, the paper underscores regional variations in the size of the shadow economy, with Eastern and Central European countries exhibiting higher levels compared to Western European Union countries. Orsi et al. (2014) provides a DSGE model with an informal sector and estimates the size and trend of the underground economy in Italy. The findings suggest a steady increase in the size of the underground economy, primarily driven by rising taxation. The paper emphasizes the importance of reducing taxes or increasing tax enforcement to improve the budgetary situation.

Both the MIMIC and DGE estimates have the advantage of covering a large sample of countries over a long time period, but also suffer from important limitations. The MIMIC approach relies on GDP (that is, GDP per capita and its growth rates) as both cause and indicator variables, and on another, independent study's base-year estimates of the informal economy to calibrate the size of the informal economy in percent of GDP. In addition, the estimates of informal economy are sensitive to the model's estimated coefficients and to alternative model specifications and sample coverage. Coming to the DGE approach, it relies on strong assumptions about the functional form of activity in the informal and formal sector and on the relationship between formal and informal productivity. Like the MIMIC approach, it requires base-year estimates of the informal economy from another independent study to calibrate the size of informal economy. Finally, a computable DGE model only captures some of the stylized facts of the informal sector, and data availability, especially for EMDEs, represents a serious challenge to matching DGE models with all aspects of informality.

The goal of our paper is to provide a novel methodology to build a transparent measure of the informal economy which relies on observed data on consumption and tax revenues, and does not suffer the limitations of specific modeling of the unobserved characteristics of the informal sector.

3 Evading Value Added Duty Economy (EVADE)

In this section, we introduce our measure of the informal economy, Evading Value Added Duty Economy (*EVADE*), based on the observed compliance on VAT payments.[7]

[7]Our measure of informal economy builds upon a measure of tax compliance constructed in Pappadà and Zylberberg (2017), which highlights that tax compliance is responsive to tax rates and sluggish. In the same vein, two recent papers discuss the impact of consumption taxes in the presence of informality (respectively constructing cross-country measures of tax compliance and informal consumption, see Bachas et al. (2020), Morrow et al. (2022)).

We focus on VAT compliance for three reasons. First, VAT is a widely used indirect tax, which represents on average about one third of total tax revenues collected by tax authorities in Europe. Second, the relevant tax base for VAT is consumption, for which National Statistical Authorities provide detailed data based on Household Surveys, which are also used for the computation of price indexes. As a result, VAT compliance can be measured as the gap between tax revenues and the "ideal" tax revenues based on reported consumption. Third, as already noted, the compliance on VAT payments represents a proxy for the overall Gross Value Added that is not reported to tax authorities, which is the bulk of the size of the informal economy. In what follows, we describe how we use VAT compliance and the output approach to measuring GDP to estimate the size of the informal economy. We provide details about the data used for the construction of our measure of the informal economy in section A in the Appendix.

3.1 A measure of the informal economy based on VAT compliance

In National Accounting, GDP may be computed using the output approach:

$$GDP_t = GVA_t + NTprod_t \tag{1}$$

where GVA_t, the Gross Value Added is the value that producers have added to goods and services; and $NTprod_t$ is the difference between Taxes on Products and Imports minus Subsidies on Products. Note that $NTprod_t$ includes VAT on imported goods, whereas it does not include VAT on exported goods, as there is no tax on the value added on domestically produced goods which are exported.[8] Our goal is to compute the difference between GDP and "actual" GDP, which includes the value added in the economy that has not been reported to tax authorities. We therefore need a measure of tax compliance on value added.

We introduce a measure of VAT compliance which compares tax receipts to expected receipts as predicted by tax rates and actual expenditures. Letting $VATrev_t$, τ_{it} and c_{it} denote VAT revenues, VAT rate and consumption of good i in year t, the *overall* VAT compliance is defined as:

$$\gamma_t = \frac{VATrev_t}{\sum_i \tau_{it} c_{it}}. \tag{2}$$

The gap between tax revenues and expected tax revenues, as captured by the distance between γ_{tc} and 1, reflects imperfect tax enforcement from tax authorities. In other words, only a share γ_t

[8] National Statistical Authorities, for instance INSEE for France, define Taxes and subsidies on products as follows. Taxes on products (D21) are taxes payable per unit of good or service produced or exchanged. Taxes on products mainly comprise value added tax, domestic tax on petroleum products, duty on transfers for valuable consideration, and duties on alcohol and tobacco. Subsidies on products (D31) are subsidies payable per unit of a good or service produced or imported. The amount of subsidies on products can be specified in the following ways: a specific amount of money per unit of quantity of a good or service; a specified percentage of the price per unit; the difference between a specified target price and the market price paid by a buyer.

of the actual value added has been reported to tax authorities.[9] The measure accounts for possible changes in consumption patterns c_{itc} as a response to differential tax rates across goods.[10]

Note that the *overall* tax compliance γ_t includes VAT revenues on domestically produced goods and imports. Morrow et al. (2022) show that international border controls improve VAT compliance, generating a correlation between imports and aggregate VAT revenues that is informative about *domestic* non-compliance. We therefore introduce the following assumption:

Assumption 1

We assume perfect tax compliance on goods that are subject to international border controls.

Corollary 1

VAT on imported goods and taxes less subsidies on products other than VAT - i.e. excises on oil and duties - are fully reported.

Assumption 1 captures the higher tax enforcement for imported goods and other taxes on products like excises on oil and duties. Similarly, subsidies are fully reported because only firms in the formal sector are eligible to claim them. The stronger tax enforcement on imported goods implied by Assumption 1 is also behind the empirical strategy used by Fisman and Wei (2004) to quantify the effects of tax rates on tax evasion. Fisman and Wei (2004) define the evasion gap as the difference between Hong Kong's reported exports to China at the product level and China's reported imports from Hong Kong. Their results show that the evasion gap is negatively correlated with tax rates on closely related products, suggesting that evasion takes place partly through misclassification of imports from higher-taxed categories to lower-taxed ones, in addition to under-reporting the value of imports.

Given Assumption 1, we can now derive the compliance on domestically produced goods and services, which we define *domestic* VAT compliance:[11]

$$\delta_t = \frac{VATrev_t - \sum_i m_t \tau_{it} c_{it}}{\sum_i (1 - m_t) \tau_{it} c_{it}}, \tag{3}$$

where m_t is the fraction of imported goods in domestic consumption. Equation (3) implies that only a share δ_t of the actual domestic value added - i.e. the value added on domestically produced and consumed goods - has been reported to tax authorities.

We can now define the GDP under "full compliance" as the GDP which includes the unre-

[9] Several European countries exempt VAT payments for firms below given turnover thresholds. As our measure does not take into account these VAT exemptions, we might underestimate the *overall* compliance. However, given that these thresholds are set at very low levels of turnover, the value added of exempted firms represent a negligible fraction of the country's value added.

[10] We are not able to measure tax compliance for single given consumption category, because we only have aggregate VAT revenues, not $VATrev_{i,t}$. However, we are able to capture changes in consumption due to different tax rates across goods (τ_{it}), so the fluctuations in tax compliance must arise from changes in compliance within good categories. We return to this issue in more detail in Section 5.1.

[11] We compute the *domestic* VAT compliance for the observed import ratio m_t. As such, it has to be interpreted as a conservative measure: the higher is the share of imported goods that goes under-reported, as suggested by Fisman and Wei (2004), the lower is the *domestic* VAT compliance.

ported value added and its revenues:

$$GDP_t^{full} = GVA_t^{full} + NTprod_t^{full},$$

where

$$GVA_t^{full} = GVA_t + \underbrace{(1-\delta_t)(1-x_t)(1-g_t)GVA_t}_{missing\ \text{GVA}},$$

$$NTprod_t^{full} = NTprod_t + \underbrace{\sum_i \tau_{it} c_{it} - VATrev_t}_{\text{missing VAT revenues}}$$

The missing GVA has to be computed on the share of domestic gross value added which is subject to VAT. We therefore exclude the fraction x_t of domestic value added which is exported and therefore tax-exempted, and the fraction g_t that is the Government consumption of goods and services, which are subject to perfect tax compliance. The missing VAT revenues $\sum_i \tau_{it} c_{it} - VATrev_t$ correspond to the gap between the VAT revenues under full compliance and the observed VAT revenues. We can then write:

$$GDP_t^{full} = GVA_t + NTprod_t + (1-\delta_t)(1-x_t)(1-g_t)GVA_t + \left(\frac{1}{\gamma_t} - 1\right) VATrev_t$$

Importantly, since our measure employs consumption survey data, we are not able to directly account for tax evasion on investment expenditures, many of which are also subject to value added tax. In order to obtain a measure of the informal economy expressed in a GDP metric, we assume that rate of tax evasion on investment is the same as on consumption.[12]

We are now ready to define the share of the informal economy according to our *EVADE* (Evading Value Added Duty Economy) methodology as:

$$EVADE_t = \frac{GDP_t^{full} - GDP_t}{GDP_t}.$$

and we obtain the following expression:

$$EVADE_t = \underbrace{(1-\delta_t)(1-x_t)(1-g_t)\frac{GVA_t}{GDP_t}}_{missing\ \text{GVA}} + \underbrace{\left(\frac{1}{\gamma_t} - 1\right)\frac{VATrev_t}{GDP_t}}_{missing\ \text{VAT revenues}}. \tag{4}$$

The main contribution of our methodology is to build an aggregate measure of the informal

[12]Tax evasion is famously high in some types of investment, for example real estate construction, in which case our assumption leads to an underestimation of the aggregate shadow economy. On the other hand, firms have a strong incentive to report deductible expenses on equipment investment, so here compliance may be higher, in which case our assumption that the rate of evasion on investment is the same as the rate on consumption is an overstatement.

economy based on indicators of VAT compliance - *overall* and *domestic* - which account for the share of goods and services subject to VAT reduced rates, and for international trade. In what follows, we explore in more detail their impact on the estimates of *EVADE*.

The role of weights on reduced VAT rates

The difference between the actual VAT revenues and the ideal VAT revenues is often referred to as VAT gap. This gap includes both the non-compliance (tax evasion) and the "policy gap", corresponding to the lower VAT revenues due to reduced rates. The *overall* tax compliance γ_t defined in equation (2) allows one to disentangle the policy gap from the VAT non-compliance, because it builds upon disaggregated data on consumption and takes into account the reduced VAT rates to which they are subject, in a similar fashion as European Commission (2020a).[13]

In order to underline the role of reduced VAT rates, we report in Figure 1 the *overall* VAT non-compliance $(1 - \gamma_t)$ for alternative weights on reduced rates. This corresponds to putting an upper and lower bound to the *overall* VAT on-compliance. The blue line is our baseline, where we take into account the average VAT rate weighted by the consumption of goods subject to standard and reduced rates. Setting the weight on reduced rate equal to 0, i.e. using the standard VAT rate for all goods and services, is equivalent to computing the standard VAT gap.

In Figure 1, the green area therefore captures the "policy gap", that is the difference between the *overall* VAT non-compliance and the VAT gap without taking into account reduced rates and exempted goods (upper bound). The grey area captures instead the difference between the *EVADE* non-compliance and the measure obtained with a weight equal to 1 on reduced rates, which underestimates the informality (lower bound).[14]

EVADE counterfactuals

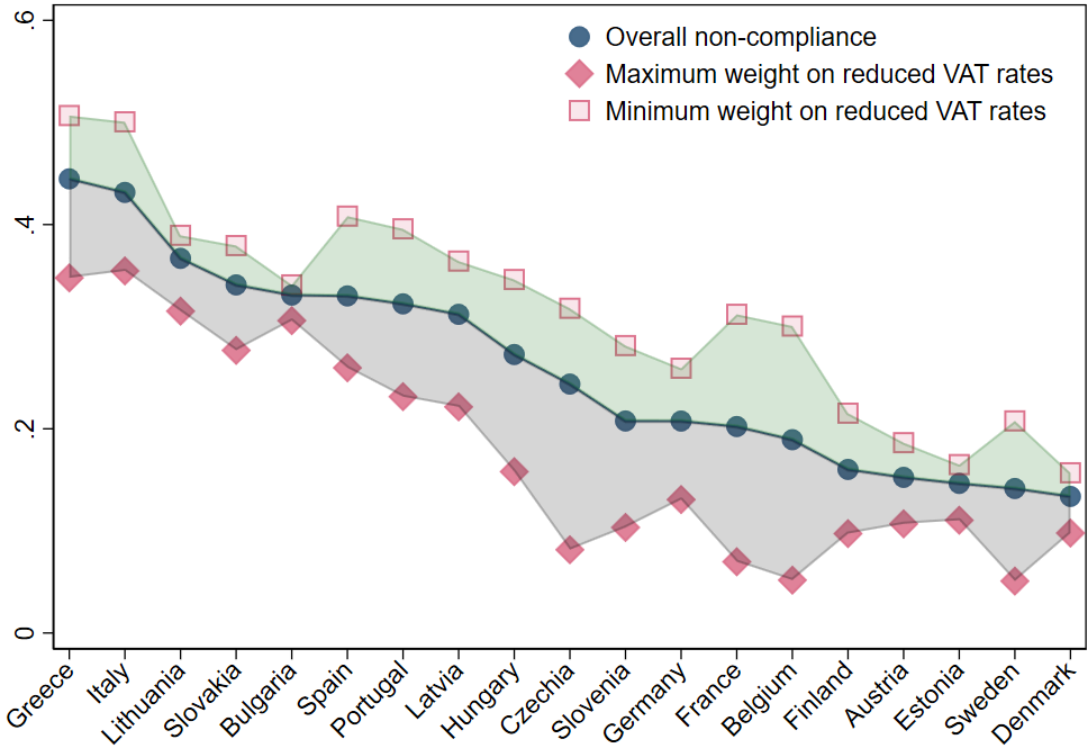
We now highlight the role of International Trade and Government consumption for our estimates of *EVADE* by constructing three counterfactual measures.[15] First, we compute *EVADE* by putting the share of exported gross value added x equal to 0. This counterfactual overestimates the size of the informal economy as it neglects the fact that some of the GVA is exported. Second, we also put the share of imported goods in consumption m equal to 0. This counterfactual, with both x and m equal to 0, still overestimates the informal economy but less than in the first case, as putting $m = 0$ neglects the positive impact of imported goods on *overall* compliance. Third, on top of shutting down international trade, we also set the share of Government consumption of goods and services equal to 0. This counterfactual also overestimates *EVADE*, because it implies

[13] See section A.1 in the Appendix for additional details on the computation of weights on reduced VAT rates.

[14] In principle, the counterfactual non-compliance obtained with a weight equal to 1 on reduced rates can be lower than 0. For instance, this is the case when the gap between the standard rate and the reduced rate and/or the share of goods taxed at reduced rates are large. In Figure 1, we exclude Croatia, which is the only country for which this counterfactual *overall* non-compliance is lower than 0.

[15] See section A.2 in the Appendix for additional details on the *EVADE* counterfactuals.

Figure 1: *Overall* non-compliance for different weights of reduced rates.

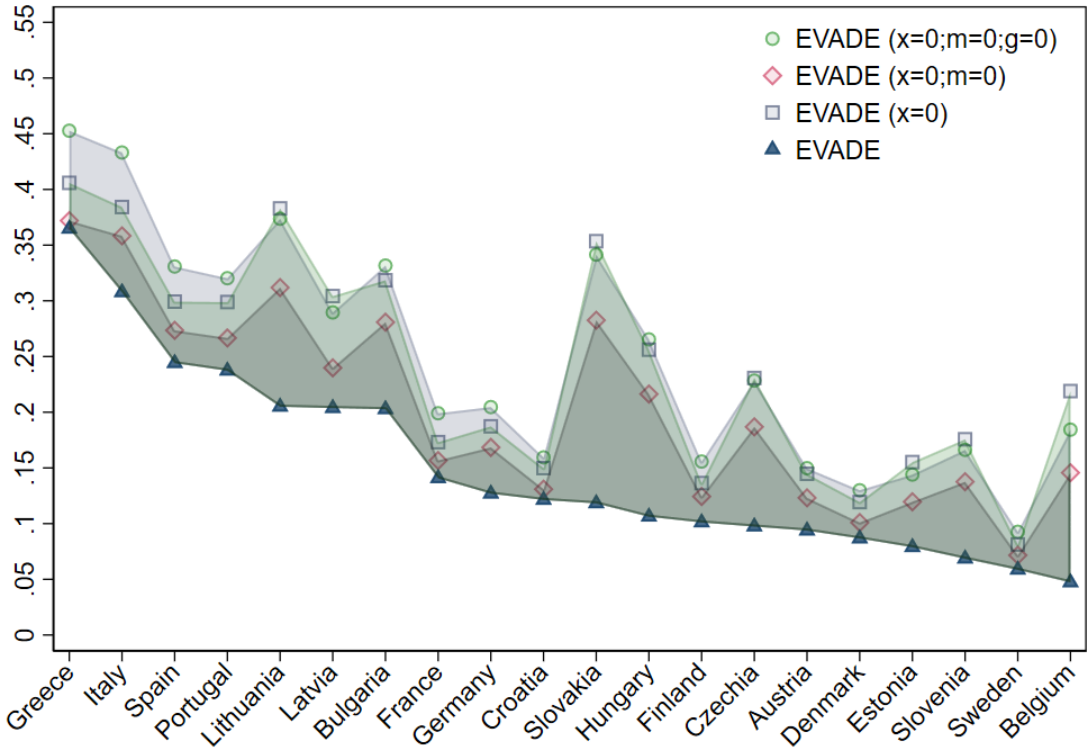


Notes: This Figure displays the *overall* VAT non-compliance (1-γ_t) by country using the appropriate weights on the reduced VAT rates, and the same variable using a weight equal to 0 on reduced rates (thus equivalent to the VAT gap), and a weight equal to 1 on reduced rates.

that the tax compliance on Government consumption of goods and services is not perfect but equivalent to the *domestic* compliance.

Figure 2 reports the average levels of these counterfactuals and the gaps with our measure *EVADE*, which instead takes into account the ratios of exports and imports observed in the data. Interestingly, the counterfactual *EVADE* with x equal to 0 displays a larger gap with respect to our baseline *EVADE* - the light and dark green areas in Figure 2 - mostly for small open Central European countries. For these countries, the share of exports over GDP is very large, because registered exports includes re-exported goods with low domestic value added; in turn, this leads to an underestimation of *EVADE*. In fact, the large gap with the *domestic* non-compliance in these countries suggests that where the share of exports over GDP is very large, there is greater potential to use misinvoicing to reduce VAT tax paid on domestic intermediate inputs, and to correspondingly overstate the value added by exporters who can openly report their export sales without paying VAT. The gaps are instead relatively smaller for larger countries, where a larger fraction of the domestic gross value added is directed to the domestic market. When we also neglect the share of imports in the domestic consumption of goods and services (dark green area in Figure 2), we dampen the gap with respect to our baseline measure *EVADE*, since m equal to 0 tends to

Figure 2: *EVADE* counterfactuals.



Notes: This Figure displays the average levels of *EVADE* and three counterfactuals: i) computing *EVADE* in equation (4) by imposing an export ratio x equal to 0; ii) computing *EVADE* in equation (4) by imposing both an export ratio x and an import ratio m equal to 0; ii) computing *EVADE* in equation (4) by imposing both an export ratio x and an import ratio m equal to 0, and the share of Government consumption of goods and services g=0.

overestimate the *overall* compliance.

Note that the light green area in Figure 2 captures the difference between *overall* and *domestic* non-compliance. Since this is relatively small, we can infer that our assumption of full compliance on imports (Assumption 1) does not have a large impact on our baseline *EVADE*. Also, the fact that the light green area is relatively small is not surprising as we would expect a larger gap between the two in less developed countries as shown by Morrow et al. (2022). Finally, the counterfactual *EVADE* with (x=0; m=0; g=0) highlights the role of Government consumption of goods and services, for which we assume that tax compliance is perfect. Relaxing this assumption tends to overestimate *EVADE* with respect to the other counterfactuals, but only to a limited extent.

4 Summary Statistics

We now turn to descriptive statistics and illustrative correlations about *EVADE*, and a comparison with alternative measures of informal economy. Table 1 includes the summary statistics for

EVADE, namely the average level of informal economy as a share of GDP, and the within-country standard deviation over the period 1999-2020. Table 1 illustrates the large heterogeneity in the size of the informal economy across European countries. Not surprisingly, GIPS countries (Greece, Italy, Spain, Portugal) are on top of the list, whereas CORE European countries such as France and Germany have significant lower levels of *EVADE*: on average, about a half of those observed in GIPS countries. Table 1 displays another important dimension of heterogeneity across European countries, which is the standard deviation of *EVADE*. Countries with lower (higher) levels of *EVADE* tend to have lower (higher) fluctuations as well, even though this is not a systematic regularity.

Table 1: Summary statistics *EVADE* (share of GDP).

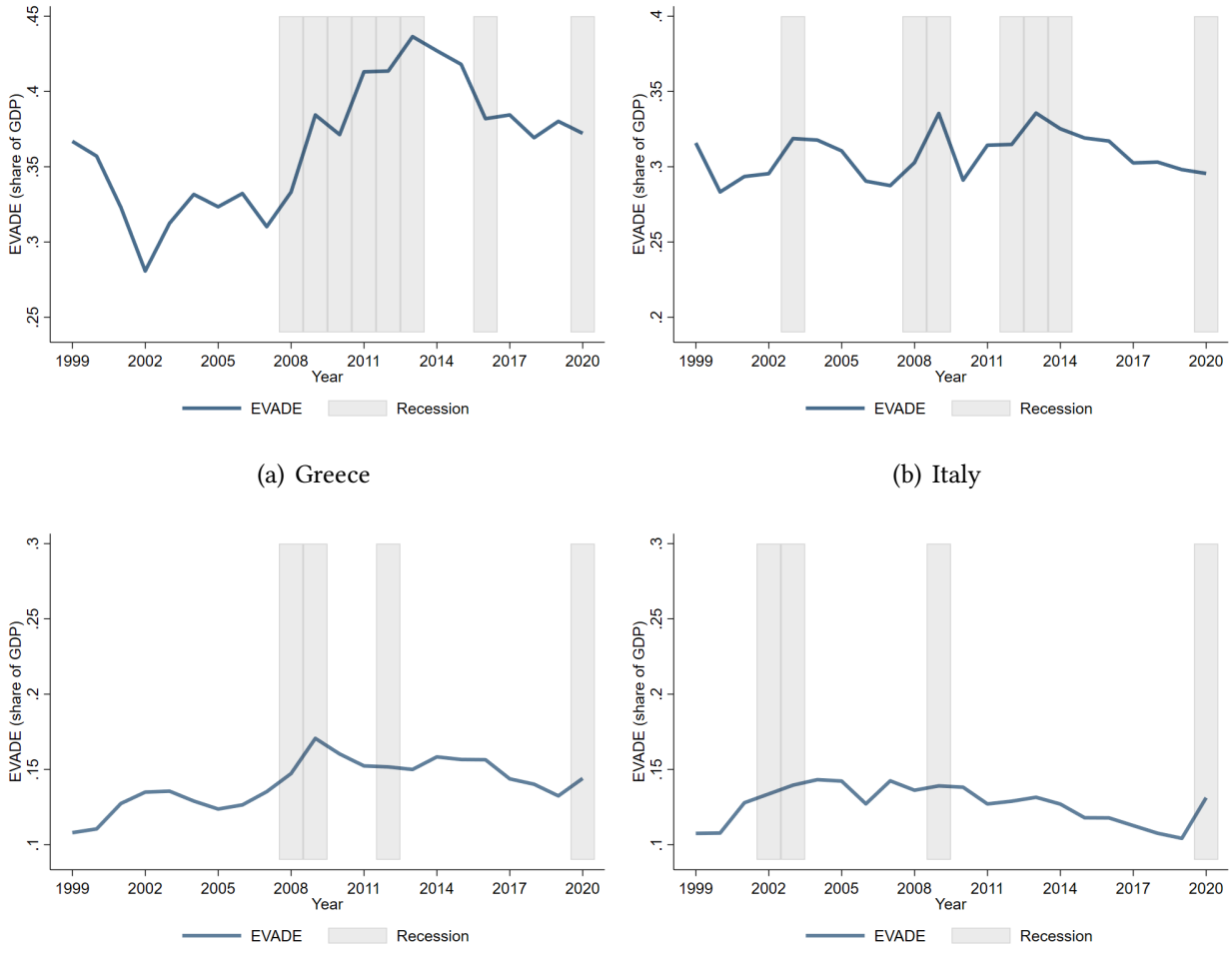
Country	Mean	Std. Deviation	Country	Mean	Std. Deviation
Greece	.36	.04	Slovakia	.12	.05
Italy	.31	.01	Hungary	.11	.04
Spain	.24	.07	Finland	.10	.02
Portugal	.24	.04	Czechia	.10	.06
Lithuania	.20	.03	Austria	.09	.01
Latvia	.20	.07	Denmark	.09	.01
Bulgaria	.20	.06	Estonia	.08	.04
France	.14	.02	Slovenia	.07	.02
Germany	.13	.01	Sweden	.06	.03
Croatia	.12	.03	Belgium	.05	.01

Notes: This Table reports the average level of *EVADE* as defined in equation (4), and the within-country standard deviation of *EVADE* over the period 1999-2020.

In Figure 3, we report the evolution of informal economy over the period 1999-2020. At least visually, the volatility of *EVADE* appears to be associated with a counter-cyclical movement of the informal economy: *EVADE* tends to increase in recessions and decrease in booms, in particular in a couple of GIPS countries like Greece and Italy. In France and Germany instead, the level of informality is more stable. Another perspective on the order of magnitude *EVADE* can change over the cycle is to look at how it behaved during the 2008-2009 global financial crisis, which can be seen in Figures A1 and A2 in the Appendix. Movements in *EVADE* were very heterogeneous across countries. For example, in Germany, peak to trough growth fell by 6.6% (and unemployment fell by 0.2%) while *EVADE* rose from 13.6% to 13.9%; whereas in Greece, growth fell by 4% (and unemployment grew by 2%), with *EVADE* rising from 33.3% to 38.4%.

As mentioned in Section 2, we are not the first to provide a measure of informality. In what follows, we focus on the differences between *EVADE* and alternative measures of the informal economy, in particular two indirect measures that represent "macroeconomic" estimates of the

Figure 3: Evolution of *EVADE*, 1999-2020.



(a) Greece

(b) Italy

(c) France

(d) Germany

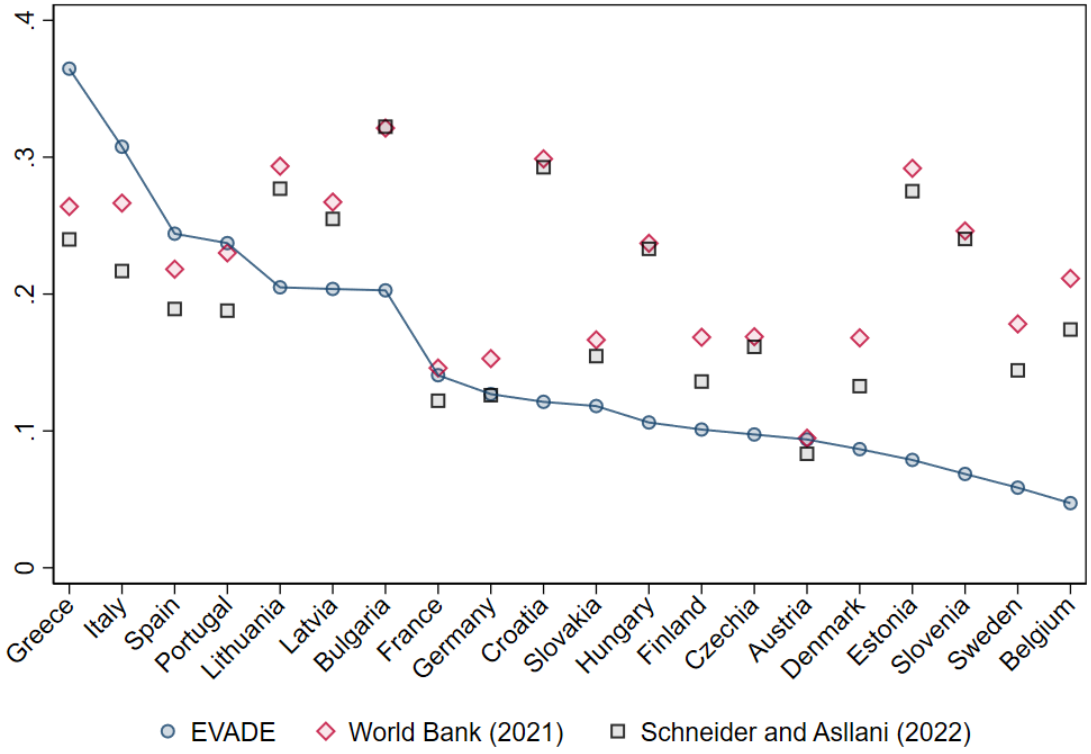
Notes: This Figure displays the time-series of *EVADE* as share of GDP. *Recession* is defined as years with negative GDP growth.

informal economy as share of GDP, i.e. those using a MIMIC approach and DGE modeling.

Figure 4 shows the gaps between *EVADE* and the measures of informal economy presented by the World Bank (2021) - based on the DGE model of Elgin et al. (2021), and Schneider and Asllani (2022) - based on the MIMIC approach. While *EVADE* is extremely close to alternative measures of informality for CORE countries such as France and Germany, it is larger for GIPS countries, and lower for Central European and smaller countries, most likely because of the downward bias due to the large fraction of exports in their value added.

Most interestingly, *EVADE* differs from alternative measures of informality along another dimension that is often overlooked in the literature: the volatility of informality. Both the DGE and MIMIC modeling deliver an estimate of the informal economy which has extremely low volatility, suggesting that the level of informal economy is a sort of "fundamental" of the economy

Figure 4: Alternative measures of informal economy - average level (share of GDP).



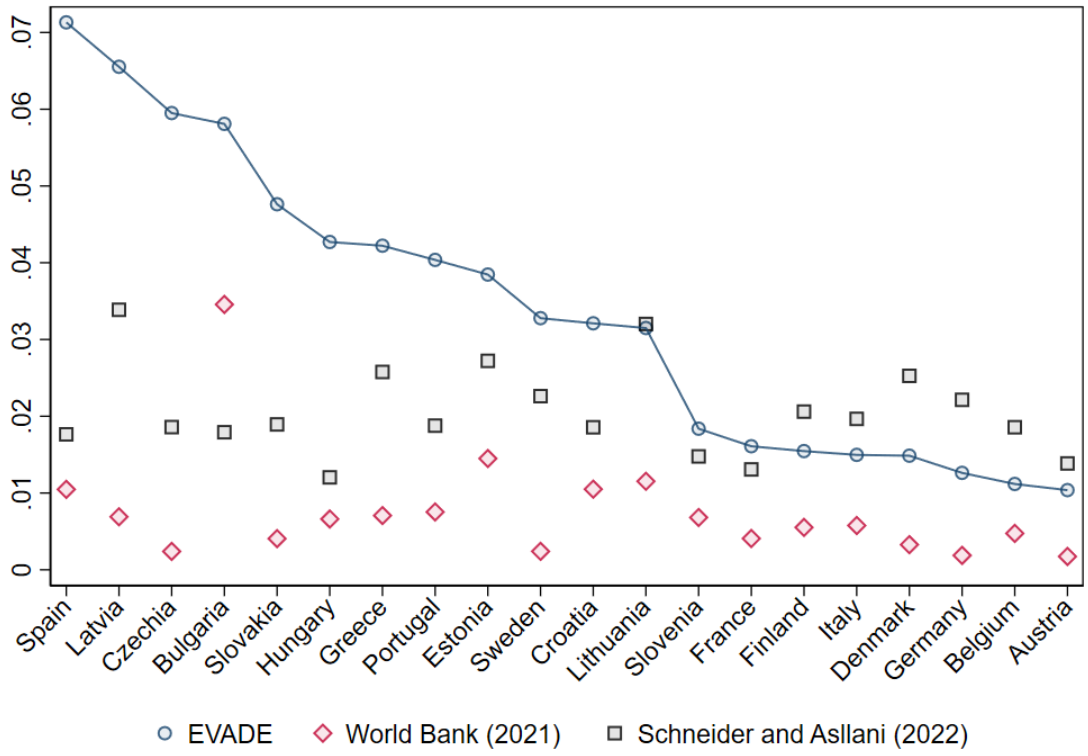
Notes: This Figure displays the average level of *EVADE* and alternative measures of informal economy such as the World Bank (Elgin et al. (2021)) and Schneider and Asllani (2022) (MIMIC).

which is constant over time. Figure 5 shows that the within-country standard deviation of *EVADE* is substantially larger than the ones by the World Bank (Elgin et al. (2021)) and Schneider and Asllani (2022) (MIMIC). The informal economy tends to be more volatile in GIPS countries, with the exception of Italy, where *EVADE* is large yet low-volatile, a situation that could be defined as an "informality trap".

How do these alternative measures of informality relate to public finance aggregates? In Figure 6, we plot these three measures of informality against some macroeconomic variables that are likely to be affected by the informal economy: the government primary surplus over GDP; sovereign debt over GDP; the yield on sovereign debt (10 years bond); and the overall value of cashless transactions over GDP.

Panel (a) of Figure 6 shows that *EVADE* is negatively correlated with the government surplus: intuitively, for given government expenditure, in countries with a larger informal economy, the government is only able to collect lower levels of tax revenues, and this leads to larger primary deficits on average. In contrast to *EVADE*, the alternative measures by the World Bank (Elgin et al. (2021)) and Schneider and Asllani (2022) (MIMIC) do not capture this regularity, as the level of

Figure 5: Alternative measures of informal economy - standard deviation.

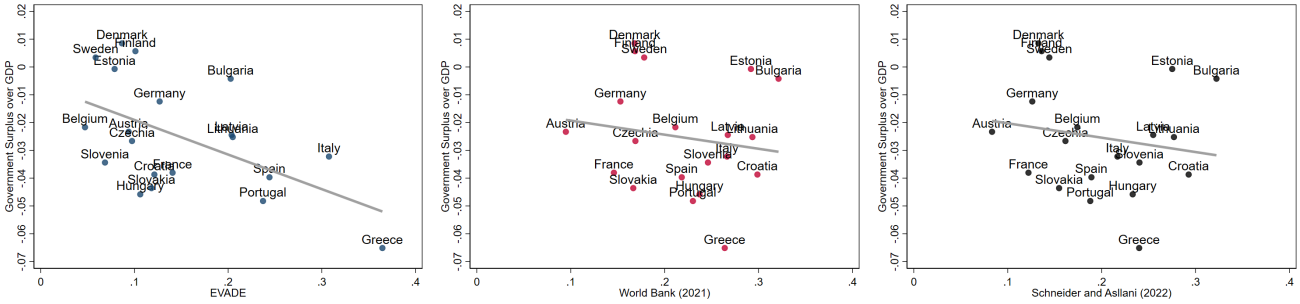


Notes: This Figure displays the standard deviation of *EVADE* and alternative measures of informal economy such as the World Bank (Elgin et al. (2021)) and Schneider and Asllani (2022) (MIMIC).

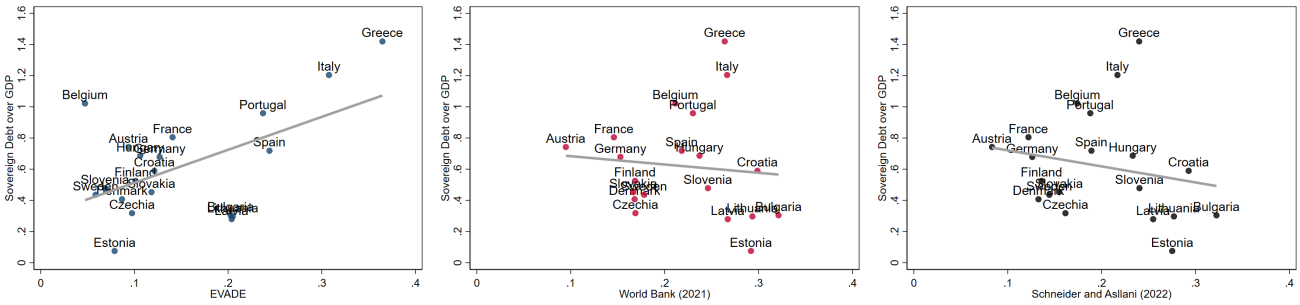
informality is not correlated at all with the average government primary surplus.[16] This pattern is confirmed by panel (b) of Figure 6. While the measures of informality based on DGE and MIMIC modeling are uncorrelated (or slightly negatively correlated) with sovereign debt, our measure of informality is positively correlated with it. Consistent with the evidence in panel (a), a higher average level of *EVADE* is associated with larger primary deficits on average, thus larger sovereign debt, in particular in GIPS countries. Panel (c) of Figure 6 shows instead that both *EVADE* and the alternative measures of informality are positively correlated with the cost of debt servicing. While this is in line with the findings for *EVADE* in panel (b), the explanation of this correlation is less straightforward for the alternative measures that do not suggest a substantial difference in terms of sovereign debt across different levels of informality. Finally, panel (d) of Figure 6 shows how informality is negatively correlated with the overall value of cashless transactions over GDP. In line with the findings in Rogoff (2016), economies where cashless payments are larger also tend to display lower levels of informality, since these payment methods make tax evasion more difficult, as these transactions are easier to track for the tax authority.

[16] We report in Table A1 in the Appendix the correlation of each variable in Figure 6 with the alternative measures of informality.

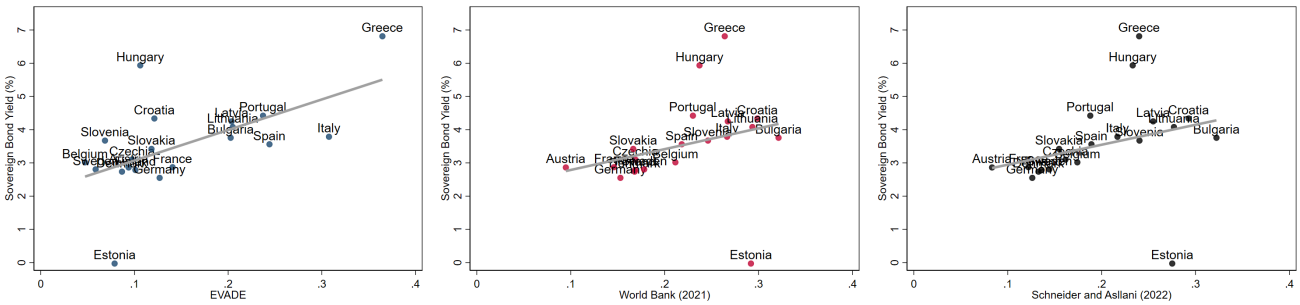
Figure 6: *EVADE* and macroeconomic aggregates.



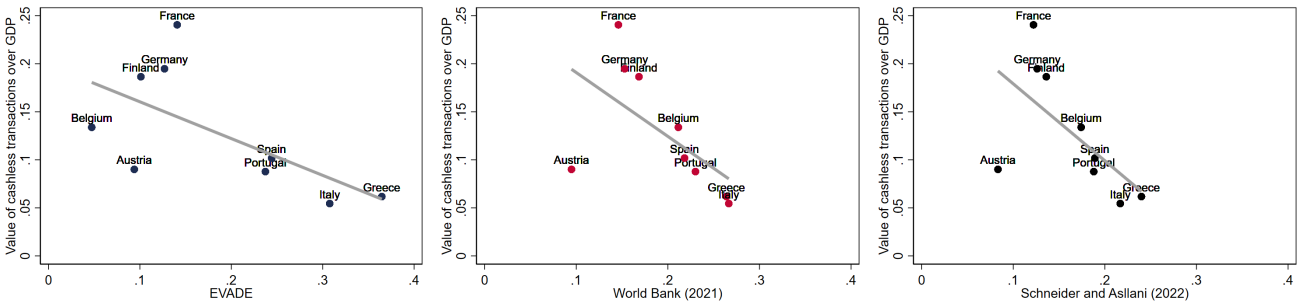
(a) Government Surplus over GDP



(b) Sovereign Debt over GDP



(c) Sovereign Bond Yield (%)

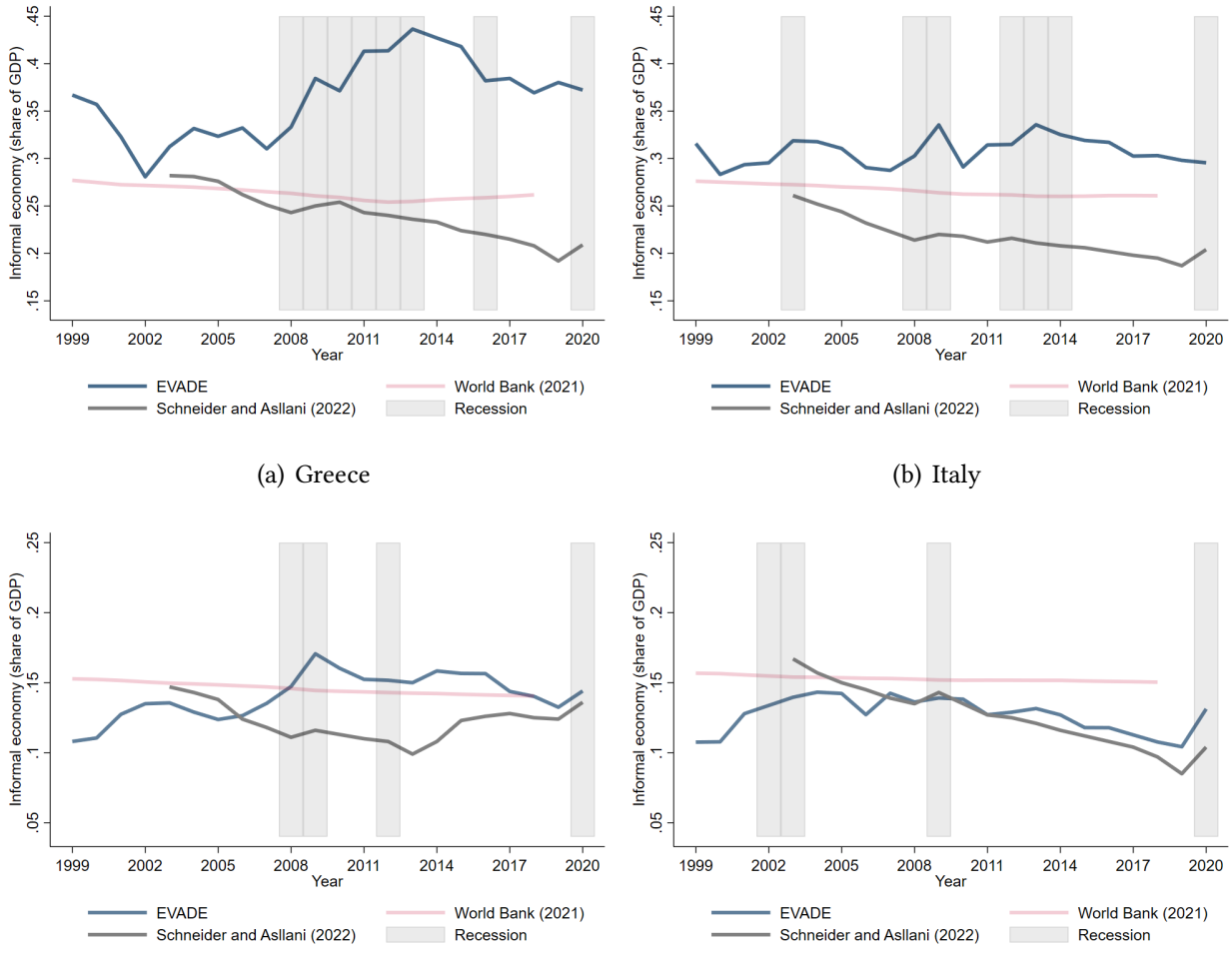


(d) Value of cashless transactions over GDP

Notes: We report the average level of *EVADE* and alternative measures of informal economy such as the World Bank (Elgin et al. (2021)) and Schneider and Asllani (2022) (MIMIC).

Finally, we report in Figure 7 the evolution of *EVADE* and alternative measures of the informal economy over the period 1999-2020.[17] *EVADE* is more volatile than the other measures, which are quite flat over the entire period. At least visually, the alternative measures of informality do not seem to capture a counter-cyclical movement: the informal economy appears to be stable (or have a slight downward trend) both in GIPS and CORE European countries, in contrast with the evolution of *EVADE*. In the next section, we will explore the cyclicality of *EVADE* more formally.

Figure 7: Evolution of the informal economy, 1999-2020.



(a) Greece

(b) Italy

(c) France

(d) Germany

Notes: This Figure displays the time-series of *EVADE* and alternative measures of informal economy such as the World Bank (Elgin et al. (2021)) and Schneider and Asllani (2022) (MIMIC). *Recession* is defined as years with negative GDP growth.

[17] The differences between our measure *EVADE* of the informal economy and those by the World Bank (Elgin et al. (2021)) and Schneider and Asllani (2022) (MIMIC) are not surprising. *EVADE* relies on annual data on observed gaps between declared gross value added and VAT revenues and consumption, whereas both the DGE and MMIC approach heavily rely on model specifications where updating is much more difficult.

5 The "Hugo effect"

There are a number of plausible reasons why the level of informality should be countercyclical, most prominently that a decline in high-paying formal jobs pushes workers into the informal sector, raising the volatility of informality. A good measure of informality should capture this effect. Relatedly, several papers have provided theoretical frameworks to explain how a high (fixed) level of informality may generate a lower volatility of unemployment.[18]

We study the correlation between the informal economy and the unemployment rate using our panel data of 21 European countries over the period 1999-2020. We explore this effect by considering a country c in year t and estimating the following baseline specification:

$$EVADE_{tc} = \alpha U_{tc} + \gamma \mathbf{X}_{tc} + \mu_c + e_{tc}, \tag{5}$$

where: $EVADE_{tc}$ is the annual level of informal economy according to our measure defined in equation (4); U_{tc} is the unemployment rate. The vector $\mathbf{X}$ includes the following set of time-varying controls: government expenditure; total tax revenues; sovereign debt; the ten year sovereign bond yield; and the annual effective VAT rate, computed using the weights on reduced rates explained in section 3.1. These controls partly take into account confounding factors co-moving with the informal economy and fiscal policy. Finally, the inclusion of country fixed effects, μ_c, conditions the analysis on country-specific trends in *EVADE*.[19]

Despite the fact that our measure of *EVADE* does not rely at all on estimates of labor supply in the formal or informal economy, we find a positive and significant correlation with the unemployment rate (see Table 2).[20] Columns (3) and (4) of Table 2 report the results for the same regression by taking as dependent variable the estimate of the informal economy built by the World Bank using the DGE approach; whereas in column (5) and (6) we take as dependent variable the measure of the informal economy estimated by Schneider and Asllani (2022) using a MIMIC approach. For both alternative measures of informality, we find a correlation very close to 0 and insignificant for the DGE approach.

We now turn to a more in-depth analysis of the countercyclical properties of the informal economy, which we term the "Hugo effect". We therefore replace the unemployment rate by the

[18] Focusing on emerging market economies (EMEs) versus developed small open economies, Horvath and Yang (2022) show that varying the degree of informality according to the MIMIC measure, explains a significant fraction of differences in unemployment dynamics across small open economies. Leyva and Urrutia (2020) show that labor regulation and informality affect macroeconomic volatility, whereas Ulyssea (2010) finds that a higher tax enforcement significantly reduces informality but has strong adverse effects on unemployment.

[19] Tax evasion is commonly believed to be associated with self-employment. Data on self-employment rely on erratic survey data, with many missing years, and very different across countries, which makes it very difficult to look at it consistently across countries. Adding self-employment as explanatory variable in our baseline specification does not affect the results about the cyclicality of EVADE.

[20] The results of the above-mentioned theoretical papers linking higher informality to smaller volatility of the unemployment rate would suggest that our estimates in Table 2 are, if anything, biased downward.

Table 2: Informal economy and the unemployment rate.

	EVADE		World Bank (2021)		Schneider and Asllani (2022)	
Informal economy	(1)	(2)	(3)	(4)	(5)	(6)
Unemployment	.0073	.0037	-.0000	-.0000	.0008	.0012
	(.0005)	(.0006)	(.0002)	(.0002)	(.0004)	(.0004)
Controls	No	Yes	No	Yes	No	Yes
Observations	437	395	397	356	360	341
Overall R-squared	0.38	0.36	0.12	0.00	0.08	0.14

Notes: Robust standard errors are reported between parentheses. The unit of observation is a country in a given year. All specifications include country-fixed effects; in columns (2), (4) and (6) we add the following controls: Debt over GDP, Government Expenditure over GDP, Tax Revenues over GDP, the 10-Year Sovereign Bond Yield, and the effective VAT rate. The dependent variable is the informal economy as defined in equation (4) of the text for the first two columns, otherwise according to the DGE approach (third and fourth column) or MIMIC approach (fifth and sixth column). *Unemployment* is the annual unemployment rate.

growth rate of GDP per capita in the econometric specification of equation (5).[21] Table 3 report the results for the OLS specification for *EVADE*, for the *overall* VAT non-compliance ($1-\gamma$), and the *domestic* VAT non-compliance ($1-\delta$). The OLS estimates in Table 3 show a positive correlation between GDP growth and the informal economy. However, these estimates are biased because the growth rate of GDP may suffer from an endogeneity issue. For this reason, the OLS specification does not provide any evidence for a causal effect of the growth rate of GDP on the size of the informal economy.[22]

We solve this issue by adopting an instrumental variable approach. We instrument the GDP growth rate by the global financial cycle in Miranda-Agrippino and Rey (2020). Indeed, the global financial cycle is likely to drive the business cycle of European economies, whereas our measure of the informal economy at the country level does not have any impact on the global financial cycle. We report in Table 3 the F-stat of the first stage when using the global financial cycle as instrumental variable for the growth rate of GDP. Since the F-stats are large (above 50), we can definitely instrument the growth rate of GDP by the global financial cycle.

The results using instrumental variables in Table 3 confirm that there is a "Hugo effect": the informal economy is counter-cyclical. A 1% increase in the growth rate of GDP, instrumented by the global financial cycle, produces a drop in the size of the informal economy of about 0.43%. Since *EVADE* is defined as the share of informality in percent of nominal GDP, a negative coefficient on real GDP growth could mean that (i) when growth declines, the level of informal activity rises in absolute terms or (ii) when growth declines, the levels of both informal and formal activity decline but informal activity declines less. The former (i) would imply that the informal economy is countercyclical, the latter (ii) that it is less procyclical than the formal economy. We therefore

[21] An additional reason for using the growth rate of GDP to study the cyclical properties of the informal economy is that we have an instrument to solve the endogeneity issues of GDP growth, the global financial cycle, which is not a good instrument for the unemployment rate.

[22] As a robustness, we report in Table A2 in the Appendix the results of the regression for *EVADE*, *overall* and *domestic* non-compliance without the set of controls.

Table 3: The "Hugo effect".

	EVADE		*overall non-compliance*		*domestic non-compliance*	
Informal economy	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)
GDP growth	.0015	-.0043	.0018	-.0035	.0010	-.0038
	(.0005)	(.0017)	(.0007)	(.0020)	(.0008)	(.0023)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	385	346	385	346	385	346
Overall R-squared	0.29	–	0.50	–	0.52	–
F-stat (first stage)	–	54.87	–	54.87	–	54.87

Notes: Robust standard errors are reported between parentheses. The unit of observation is a country in a given year. All specifications include country-fixed effects and the following controls: Debt over GDP, Government Expenditure over GDP, Tax Revenues over GDP, the 10-Year Sovereign Bond Yield, and the effective VAT rate. The dependent variable is the informal economy as defined in equation (4) in columns (1) and (2); the *overall* non-compliance $(1-\gamma_t)$ as defined by equation (2) in columns (3) and (4); the *domestic* non-compliance $(1-\delta_t)$ as defined by equation (3) in columns (5) and (6). *GDP growth* is the annual growth rate of GDP instrumented by the global financial cycle in Miranda-Agrippino and Rey (2020).

run the same regression using the IV approach for the *overall* and the *domestic* non-compliance, which are not defined as share of GDP. The results in Table 3 confirm that our measure *EVADE* of the informal economy is countercyclical.

Table 4: The "Hugo effect" - Alternative measures of informality.

	World Bank (2021)		Schneider and Asllani (2022)	
Informal economy	(OLS)	(IV)	(OLS)	(IV)
GDP growth	.0008	.0000	.0014	.0015
	(.0001)	(.0003)	(.0003)	(.0006)
Controls	Yes	Yes	Yes	Yes
Observations	346	346	341	302
Overall R-squared	0.01	–	0.12	–
F-stat (first stage)	–	54.87	–	93.78

Notes: Robust standard errors are reported between parentheses. The unit of observation is a country in a given year. All specifications include country-fixed effects and add the following controls: Debt over GDP, Government Expenditure over GDP, Tax Revenues over GDP, the 10-Year Sovereign Bond Yield, and the effective VAT rate. The dependent variable is the informal economy according to the DGE approach in columns (1) and (2), and MIMIC approach in columns (3) and (4). In the IV regression, *GDP growth* is the annual growth rate of GDP instrumented by the global financial cycle in Miranda-Agrippino and Rey (2020).

In Table 4, we explore whether the World Bank estimates of the informal economy using the DGE approach, and the informal economy in Schneider and Asllani (2022) using a MIMIC approach capture the "Hugo effect". The results show that using the alternative measures of informality, which are relatively constant over the cycle, have a much smaller and typically not significant effect.

We now take stock of our results. First, our methodology to measure *EVADE* – the size of

the informal economy – differs from existing indirect measures of informality as it is not model-dependent, and it is more transparent since it relies on micro data on consumption surveys and tax revenues from the tax authority. Second, the volatility of *EVADE* is larger than the volatility of alternative measures of the informal economy. Third, one possible explanation for this larger volatility is the countercyclical property of *EVADE*, which the alternative measures do not capture.

5.1 Compositional factors of the "Hugo effect"

This paper makes use of publicly available data, but it is possible in principle to draw out much more nuanced results with the more granular tax collection data available to national authorities. In particular, the available data for the computation of EVADE do not allow a decomposition of the sector-compositional effects behind the cyclicality of EVADE. In fact, one would ideally be able to decompose the "Hugo effect" into sector-specific responses of the informal economy to business cycle fluctuations from changes in the sector composition of GDP. In particular, the estimation of the cyclicality of EVADE across different types of goods or sectors would be a powerful instrument for policymakers designing tax reforms over the business cycle, as they would be able to take into account the sector-specific response of the informal economy.

In what follows, we explain which data are needed in order to to decompose the sectoral cyclicality of *EVADE*. First, we could rewrite the *overall* compliance γ_t of equation (2) as

$$\gamma_t = \sum_i \gamma_{it} \frac{c_{it}}{c_t},$$

where $\gamma_{it} = \frac{VATrev_{it}}{\tau_{it} c_{it}}$ is the good-specific *overall* compliance, and $\frac{c_{it}}{c_t}$ is the weight of consumption of good i in total consumption.

Taking logs of variables, one could then decompose the changes over time in *overall* compliance $\Delta\gamma_t \equiv \gamma_{t+1} - \gamma_t$ as:

$$\Delta\gamma_t = \underbrace{\sum_i \Delta\gamma_{it} \times \frac{\overline{c_i}}{c_t}}_{\text{sector-specific compliance}} + \underbrace{\sum_i \overline{\gamma_i} \times \Delta\frac{c_{it}}{c_t}}_{\text{sector-compositional effects}}$$

where:

- $\sum_i \Delta\gamma_{it} \times \frac{\overline{c_i}}{c_t}$ reports the changes in overall compliance for given share of consumption of good i in total consumption. With respect to the counter-cyclicality of *EVADE*, this factor would tell us how much of the increase of *EVADE* during recessions is due to the fall in compliance regardless of changes in the composition of the consumption basket.

- $\sum_i \overline{\gamma_i} \times \Delta\frac{c_{it}}{c_t}$ reports the changes in overall compliance due to sector-compositional effects. With respect to the counter-cyclicality of *EVADE*, this factor would tell us how much of the increase of *EVADE* during recessions is due uniquely to changes in the composition of the consumption basket, for given compliance at the sector-specific level $\overline{\gamma_i}$.

This decomposition could help in exploring the counter-cyclicality of *EVADE* because it would tell us i) whether the informal economy increases in a heterogeneous way across sectors, and ii) how much of the cyclicality of EVADE is due to an increase in the share of consumption goods for which tax compliance is relatively smaller.

Unfortunately, the data required for this decomposition are not publicly available, so it is not possible to compute the sector-specific *overall* compliance $\gamma_{it} = \frac{VATrev_{it}}{\tau_{it} c_{it}}$ because we only have aggregate VAT revenues, not the sector-specific VAT revenues $VATrev_{it}$.[23] However, National Statistical Authorities collect data on tax revenues and observe VAT revenues by typology of good, which allows to do this decomposition. We leave this research avenue as an indication for future researchers and National Statistical Authorities to explore. In principle, the estimation of the cyclicality of EVADE across different types of goods is an important instrument for policymakers when designing tax reforms, allowing them to take into account the response of the informal economy at a disaggregated level over the business cycle.

6 Conclusions

This paper has developed a simple, relatively transparent measure of the size of the informal economy, which we term *EVADE*, that can be applied to any country in Europe. It does not require having separate – and potentially very different – DSGE models for each country, nor does it require ad-hoc or statistical weighting of a variety of alternative indirect measures, and it does not need any assumptions about knowing the size of the informal economy in a baseline year. Our measure has especially more pronounced variation across time than previous measures and is thus consistent with the view that informality is countercyclical, see Andreoni (1992).

We find a positive correlation with unemployment in a panel regression across countries, even after controlling for tax rate differences, suggesting that flows in and out the informal sector are quite responsive to economic conditions (the "Hugo effect"), and potentially also to policy. For example, our estimates may help explain the social and political resilience of the periphery countries to prolonged period of severe macroeconomic stress. The "Hugo effect" is sizable: we find that a 1% increase in the growth rate of GDP, instrumented by the global financial cycle, produces a drop in the size of the informal economy of about 40 basis points.

We acknowledge that our VAT-based *EVADE* measure is particularly applicable to the European Union, not only because its members have closely aligned systems and data collection methods, but because the VAT tax is large and important. The VAT is also likely to be by far the most important source of tax evasion. To the extent we are missing components of the informal economy, for example illegal activity that does not show up in consumption surveys, the

[23] Note that if we had a sector-specific VAT revenues $VATrev_i$ at a given point in time 0, we could compute the γ_{i0} and assume this term to be constant over time. Then, we could simply compute the sector-compositional effect as $\sum_i \overline{\gamma_{i0}} \times \Delta \frac{c_{it}}{c_t}$ and attribute the residual change in overall compliance to sector-specific compliance.

estimates we present are likely conservative.[24]

The methodology can, in principle, be applied to countries outside of Europe, at least where VAT tax is a major component of government revenue, but we leave that to further research.[25] Finally, our relatively simple and transparent approach gives broadly similar orders of magnitudes to the existing MIMIC and DSGE measures, and underscores the point that the informal economy in many European countries is extremely large and economically significant. In particular, these findings suggest that the monetary and fiscal authorities should take more seriously into account the informal economy, and the possible consequences related to its counteryclical behavior.

[24]With respect to other measures of informality, *EVADE* relies on VAT and on household consumption surveys, thus it gives more prominence to production that can be better identified within these surveys (e.g. repairs), whereas this may be less true for other sectors, such as financial services. Keen (2008) argues that VAT may provide incentives to formality, because VAT refunds can only be claimed by reporting sales, suggesting that our estimates can be considered underestimates.

[25]The issues surrounding the informal economy in low-income and low-middle income countries are arguably quite distinct from these in Europe, see Perry et al. (2007).

References

Aguiar, Mark and Mark Bils, "Has consumption inequality mirrored income inequality?," *American Economic Review*, 2015, *105* (9), 2725–56.

Alesina, Alberto F. and Silvia Ardagna, "Large Changes in Fiscal Policy: Taxes Versus Spending," Working Paper 15438, National Bureau of Economic Research October 2009.

Alesina, Alberto, Omar Barbiero, Carlo Favero, Francesco Giavazzi, and Matteo Paradisi, "Austerity in 2009-2013," NBER Working Papers 20827, National Bureau of Economic Research January 2015.

Andreoni, James, "IRS as loan shark tax compliance with borrowing constraints," *Journal of Public Economics*, October 1992, *49* (1), 35–46.

Artavanis, Nikolaos, Adair Morse, and Margarita Tsoutsoura, "Measuring Income Tax Evasion Using Bank Credit: Evidence from Greece," *The Quarterly Journal of Economics*, 2016, *131* (2), 739–798.

Aruoba, S Borağan, "Institutions, tax evasion, and optimal policy," *Journal of Monetary Economics*, 2021, *118*, 212–229.

Auerbach, Alan J. and Yuriy Gorodnichenko, "Measuring the Output Responses to Fiscal Policy," *American Economic Journal: Economic Policy*, May 2012, *4* (2), 1–27.

Bachas, Pierre, Lucie Gadenne, and Anders Jensen, "Informality, Consumption Taxes, and Redistribution," Technical Report, National Bureau of Economic Research 2020.

Dellas, Harris, Dimitris Malliaropulos, Dimitris Papageorgiou, and Evangelia Vourvachaki, "Fiscal policy with an informal sector," 2017.

Durán-Cabré, José M, Alejandro Esteller-Moré, and Luca Salvadori, "Cyclical Tax Enforcement," *Economic Inquiry*, October 2020, *58* (4), 1874–1893.

Elgin, C. and O. Oztunali, "Shadow Economies Around the World: Model Based Estimates," Technical Report, Working Paper No. 2012/05, Bogazici University, Department of Economics, Istanbul. 2012.

_ , M. A. Kose, F. Ohnsorge, and S. Yu, "Understanding Informality," Technical Report, CERP Discussion Paper 16497, Centre for Economic Policy Research, London. 2021.

Engel, Eduardo and James R Hines, "Understanding tax evasion dynamics," 1999.

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

European Commission, "Study and Reports on the VAT Gap in the EU-28 Member States," Technical Report, European Commission Final Report 2020.

_ , "Vat Rates Applied in the Member States of European Union, Situation on 1st of January 2020," Technical Report, European Commission Report 2020.

Favero, Carlo, Francesco Giavazzi, and Jacopo Perego, "Country Heterogeneity and the International Evidence on the Effects of Fiscal Policy," *IMF Economic Review, Palgrave Macmillan*, November 2011, *59* (4), 652–682.

Fisman, Raymond and Shang-Jin Wei, "Tax Rates and Tax Evasion: Evidence from Missing Imports in China," *Journal of Political Economy*, April 2004, *112* (2), 471–500.

Granda-Carvajal, Catalina and Danny García-Callejas, "Informality, tax policy and the business cycle: exploring the links," *International Tax and Public Finance*, February 2023, *30* (1), 114–166.

Horvath, Jaroslav and Guanyi Yang, "Unemployment dynamics and informality in small open economies," *European Economic Review*, 2022, *141* (C).

Keen, Michael, "VAT, tariffs, and withholding: Border taxes and informality in developing countries," *Journal of Public Economics*, October 2008, *92* (10-11), 1892–1906.

Kolsrud, Jonas, Camille Landais, and Johannes Spinnewijn, "The value of registry data for consumption analysis: an application to health shocks," *Journal of Public Economics*, 2019.

La Porta, Rafael and Andrei Shleifer, "Informality and Development," *Journal of Economic Perspectives*, Summer 2014, *28* (3), 109–126.

Leyva, Gustavo and Carlos Urrutia, "Informality, labor regulation, and the business cycle," *Journal of International Economics*, 2020, *126* (C).

Loayza, Norman V., "Informality in the Process of Development and Growth," *The World Economy*, December 2016, *39* (12), 1856–1916.

Medina, Leandro and Mr. Friedrich Schneider, "Shadow Economies Around the World: What Did We Learn Over the Last 20 Years?," IMF Working Papers 2018/017, International Monetary Fund January 2018.

Miranda-Agrippino, Silvia and Hélène" Rey, "The Global Financial Cycle after Lehman," *AEA Papers and Proceedings*, May 2020, *110*, 523–528.

Morrow, Peter, Michael Smart, and Artur Swistak, "VAT compliance, trade, and institutions," *Journal of Public Economics*, 2022, *208* (C).

Ohnsorge, F. and S. Yu, "The Long Shadow of Informality: Challenges and Policies," Technical Report, Washington, DC: World Bank. 2021.

Orsi, Renzo, Davide Raggi, and Francesco Turino, "Size, Trend, and Policy Implications of the Underground Economy," *Review of Economic Dynamics*, July 2014, *17* (3), 417–436.

Pappa, Evi, Rana Sajedi, and Eugenia Vella, "Fiscal consolidation with tax evasion and corruption," *Journal of International Economics*, 2015, *96* (S1), 56–75.

Pappadà, Francesco and Yanos Zylberberg, "Austerity and tax compliance," *European Economic Review*, 2017, *100* (C), 506–524.

_ **and** _ , "The dynamics of informality and fiscal policy under sovereign risk," Technical Report, PSE mimeo 2023.

Perry, Guillermo E., William F. Maloney, Omar S. Arias, Pablo Fajnzylber, Andrew D. Mason, and Jaime Saavedra-Chanduvi, *Informality : Exit and Exclusion* number 6730. In 'World Bank Publications - Books.', The World Bank Group, December 2007.

Pomeranz, Dina, "No taxation without information: Deterrence and self-enforcement in the value added tax," *The American Economic Review*, 2015, *105* (8), 2539–2569.

Restrepo-Echavarria, Paulina, "Macroeconomic volatility: The role of the informal economy," *European Economic Review*, 2014, *70* (C), 454–469.

Rogoff, Kenneth S., *The Curse of Cash* number 10798. In 'Economics Books.', Princeton University Press, 2016.

Romer, Christina D. and David H. Romer, "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks," *American Economic Review*, June 2010, *100* (3), 763–801.

Schneider, F. and A. Asllani, "Taxation of the Informal Economy in the EU," Technical Report, Publication for the Economic and Monetary Affairs Subcommittee on tax matters (FISC), Policy Department for Economic, Scientific and Quality of Life Policies, European Parliament, Luxembourg 2022.

Schneider, Friedrich, Andreas Buehn, and Claudio E. Montenegro, "Shadow economies all over the world : new estimates for 162 countries from 1999 to 2007," Policy Research Working Paper Series 5356, The World Bank June 2010.

Ulyssea, Gabriel, "Regulation of entry, labor market institutions and the informal sector," *Journal of Development Economics*, January 2010, *91* (1), 87–99.

APPENDIX

A Data

We use Eurostat data for 20 countries between 1999 and 2020 on total VAT revenues, VAT rates and consumption to compute the *overall* tax compliance according to equation (2).[26] We rely on the Eurostat harmonized 48 COICOP (Classification of Individual Consumption by Purpose) subcategories of goods for reported consumption based on annual household expenditure surveys.[27] The information in household surveys comes from the purchaser side thereby alleviating underreporting of undeclared transactions.

VAT rates are broadly determined by the VAT directive of the European Union. The VAT directive restricts the goods and services that can be taxed at a reduced rate based on the list in Annex III of the VAT Directive; countries in the European Union put reduced tax on the goods and services that they choose from the list of Annex III, see European Commission (2020b). The standard and reduced tax rates are partly flexible based on the range determined by the VAT directive. We extract from the European Commission the different VAT rates and we reference COICOP good categories that are subject to these rates for each country/year. For instance, categories like medical services, international public transport, basic food products or cultural services are subject to reduced rates or exemptions. There are frequent adjustments in the composition of exempted categories. Volatility in the effective VAT rate derives from large, infrequent changes in standard rates, and from smaller, frequent adjustments in the composition of exempted or reduced-rates categories.

Since the tax codes of the countries and the EU VAT directive do not always fit the categorization according to the COICOP, the VAT rates are not available for each subcategory of COICOP. For example, food is a subcategory in COICOP and the consumption level of food is available in Household Budget Surveys. However, different goods and services in the food category can be

[26] We report here the source of data for each variable. Eurostat: GDP [NAMA_10_GDP_custom_3191698], VAT Revenues [gov_10a_taxag], Gross Value Added [nama_10_gdp], Import by CPA 2008 [DS-057009_custom_3398633], Export Values [DS-057009_custom_3333240], Consumption by Purpose 12 [NAMA_10_CO3_P3_custom_3398981], Consumption by Purpose 48 [NAMA_10_CO3_P3_custom_3432239], Imports by BEC [DS-057555_custom_4022240], Debt to GDP [GOV_10DD_EDPT1_custom_4660772], Government Expenditure [GOV_10A_MAIN_custom_4827836], Tax Revenue to GDP [GOV_10A_TAXAG_custom_4828483], Government Surplus to GDP [GOV_10DD_EDPT1_custom_5768387], Government Final Consumption [NAMA_10_GDP_custom_7101975]. IMF IFS: Unemployment [A.LUR_PT]. ECB: Interest Rate Yearly [IRS], Value of Total Payments [PSS]. World Bank WDI: Real GDP Per Capita [NY.GDP.PCAP.KD].

[27] These household surveys are standardized across countries, and they follow similar methodology (i.e., sampling and questionnaire). The aggregate consumption constructed from these surveys strongly correlates with total output, but there exists (standard) measurement error (see Aguiar and Bils, 2015; Kolsrud et al., 2019, for a correction method and a comparison with registry data). This error will translate into a measurement error in the denominator of our expression for γ_{tc}.

taxed with a standard, a reduced or zero rate. Therefore, to determine an effective VAT rate for the food category, we need the weights of the goods in the food category taxed with standard or reduced rates.

A.1 Reduced VAT rates

To determine the weights of goods with reduced rates for the categories with both standard rate and reduced rates, we rely on the 2020 final report of the "Study and Reports on the VAT Gap in the EU-28 Member States", European Commission (2020a). The report includes the level of standard and reduced VAT rates applied in the member states of the European Union, as well as the list of the exempted goods. Moreover, this report provides an estimate for 2018 of the policy gap, which is an indicator of the additional VAT revenue that could theoretically (i.e. under the assumption of perfect tax compliance) be generated under a uniform VAT rate.

The policy gap therefore represents a convincing proxy for the weights of reduced rates. Since the policy gap is available only at the country level, we assume that the weights for reduced rates are the same for different subcategories of COICOP. Moreover, if there is more than one reduced rate for a subcategory of COICOP, we first take the average of these reduced rates to determine the overall reduced rate for the category. We then use the policy gap to determine the weight of the reduced and standard rate and compute the effective VAT rate for that category.

A.2 *EVADE* counterfactuals

To measure the *domestic* VAT compliance, δ_t, we need the import rates of the consumption goods and services for each subcategory of COICOP in addition to the effective tax rates and consumption levels. Eurostat provides the total import rates with the Broad Economic Categories (BEC). In this categorization, we sum the total of consumption goods and services imported. Final consumption import weight is the total of consumption goods imported as a fraction of total consumption goods. Since import weights are not available at the level of COICOP categories but at the country level, we assume the same consumption import rate across different consumption categories. Lastly, to calculate our measure of informal economy, we also need export shares, GDP and GVA. For GDP and GVA, we use the nominal values for GDP and GVA provided by Eurostat. For export shares, we use the export data of Eurostat which provides the total value of exported goods and services. The export shares are total value of exports as a fraction of GDP. Finally, we compute g as share of GDP using the Eurostat data on final consumption expenditure by general government, which includes the value of goods and services purchased or produced by general government.

A.3 *EVADE*, Unemployment and Growth

Figure A1: Evolution of *EVADE* and the unemployment rate, 1999-2020.

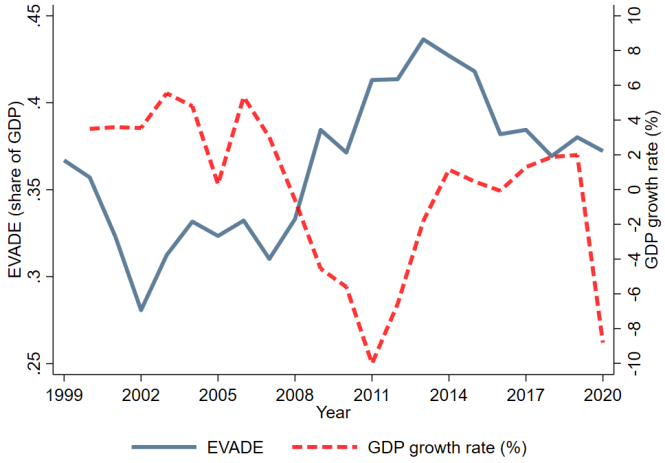
(a) Greece

(b) Italy

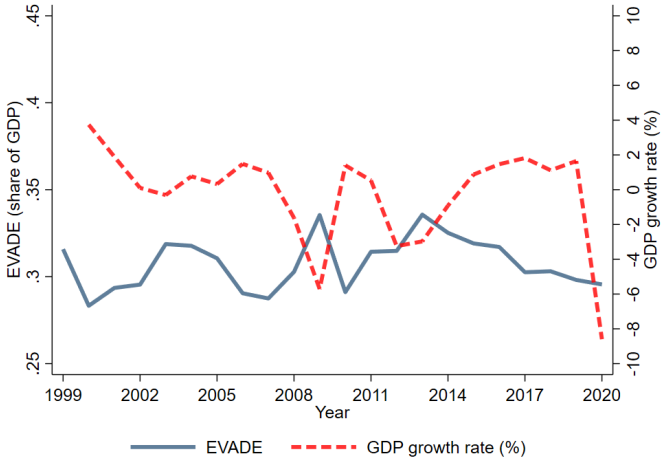
(c) France

(d) Germany

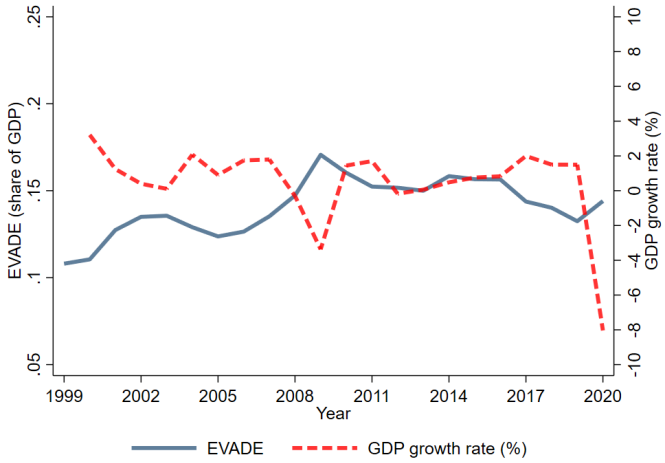
Figure A2: Evolution of *EVADE* and the growth rate of GDP, 1999-2020.



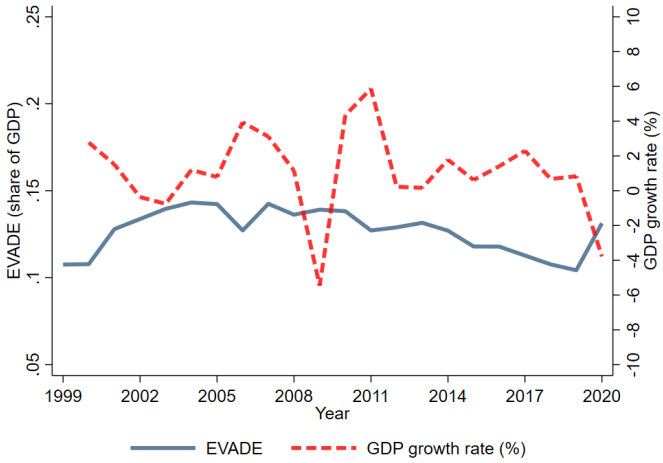
(a) Greece



(b) Italy



(c) France



(d) Germany

A.4 Correlations and Regression Analysis: Alternative Measures of Informality, Macroeconomic Variables and Robustness "Hugo effect"

Table A1: Correlation of informality and macroeconomic variables.

	EVADE	World Bank (2021)	Schneider and Asllani (2022)
Government Surplus (% GDP)	-.4255*	-.0755	-.1118
Sovereign Debt (% GDP)	.5018*	-.1164	-.2352*
Sovereign Bond Yield	.3850*	.3277*	.4362*
Value of cashless transactions (% GDP)	-.3826*	-.3555*	-.3376*

Notes: We report the correlation of each macroeconomic variable with different measures of informality. A star denotes a p-value<0.01. The data on value of cashless transactions cover a smaller number of countries.

Table A2: The "Hugo effect" - Robustness.

	EVADE		*overall non-compliance*		*domestic non-compliance*	
Informal economy	(OLS)	(IV)	(OLS)	(IV)	(OLS)	(IV)
GDP growth	-.0018	-.0076	-.0030	-.0125	-.0043	-.0161
	(.0005)	(.0016)	(.0007)	(.0023)	(.0009)	(.0028)
Controls	No	No	No	No	No	No
Observations	417	377	417	377	417	377
Overall R-squared	0.02	–	0.01	–	0.00	–
F-stat (first stage)	–	58.91	–	58.91	–	58.91

Notes: Robust standard errors are reported between parentheses. The unit of observation is a country in a given year. All specifications include country-fixed effects. The dependent variable is the informal economy as defined in equation (4) in columns (1) and (2); the *overall* non-compliance $(1 - \gamma_t)$ as defined by equation (2) in columns (3) and (4); the *domestic* non-compliance $(1 - \delta_t)$ as defined by equation (3) in columns (5) and (6). *GDP growth* is the annual growth rate of GDP instrumented by the global financial cycle in Miranda-Agrippino and Rey (2020).