

Mutascu, Mihai; Hegerty, Scott W.

Article

The role of refugees in the underground economy of the European Union

IZA Journal of Development and Migration

Provided in Cooperation with:

IZA – Institute of Labor Economics

Suggested Citation: Mutascu, Mihai; Hegerty, Scott W. (2022) : The role of refugees in the underground economy of the European Union, IZA Journal of Development and Migration, ISSN 2520-1786, Sciendo, Warsaw, Vol. 13, Iss. 1, pp. 1-19, <https://doi.org/10.2478/izajodm-2022-0002>

This Version is available at:

<https://hdl.handle.net/10419/298711>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

Mihai Mutascu^{1,2,3,*} and Scott W. Hegerty⁴

The role of refugees in the underground economy of the European Union

Abstract

This paper explores the impact of refugees on the size of the underground economy in 28 European Union countries over the period from 1998 to 2017. It applies a nonlinear methodology by employing dynamic panel threshold estimations. The main findings uncover a nonlinear connection between refugees and the informal economy with an inverted V-shape and a different magnitude of effects depending on the share of the refugee population. The underground economy is stimulated at a low level of refugee inflows (where immigrants make up <0.572% of the total population). Large inflows compress the underground economy, which increases competition in the labor market based on lower labor costs. Economic growth and international trade play a crucial role in reducing the size of the informal economy. Equally importantly, coherent unemployment policy and adequate regulation of illegal immigrants support this process.

Current version: February 11, 2022

Keywords: refugees, underground economy, implications, European Union

JEL codes: F22, O17, C23

Corresponding author: Mihai Mutascu
mihai.mutascu@zu.de; mihai.mutascu@e-uvt.ro

1 Zeppelin Chair of International and Digital Economics, Zeppelin University of Friedrichshafen, Am Seemooser Horn 20, 88045 Friedrichshafen, Germany

2 Department of Finance, Faculty of Economics and Business Administration, West University of Timisoara, Romania

3 Laboratoire d'Economie d'Orléans (LEO), UMR7322, Faculté de Droit d'Economie et de Gestion, University of Orléans, France

4 Department of Economics, Northeastern Illinois University, 5500 N. Saint Louis Avenue, Chicago, IL 60625, USA

1 Introduction

In recent years, many European Union (EU) member countries have been confronted with inflows of migrants, most of whom invoke refugee status. This demographic movement has generated heated debates, not only in the sociopolitical environment but also among researchers. A new set of challenges now face the EU space, with economic challenges assuming key importance. Generally, the inflow of both legal and illegal immigrants modifies the aggregate size of an economy, influences the level of wages and the labor force participation rate, generates revenue inequalities in respect to native population, and affects the net fiscal burden (Becker and Ferrara, 2019; Verme and Schuettler, 2021). Given many current geopolitical issues (such as violent conflicts in Syria, Iraq, Afghanistan, Pakistan, the Horn of Africa, and the Sahel), a parallel inflow of refugees accentuates the phenomenon of migration in the EU.

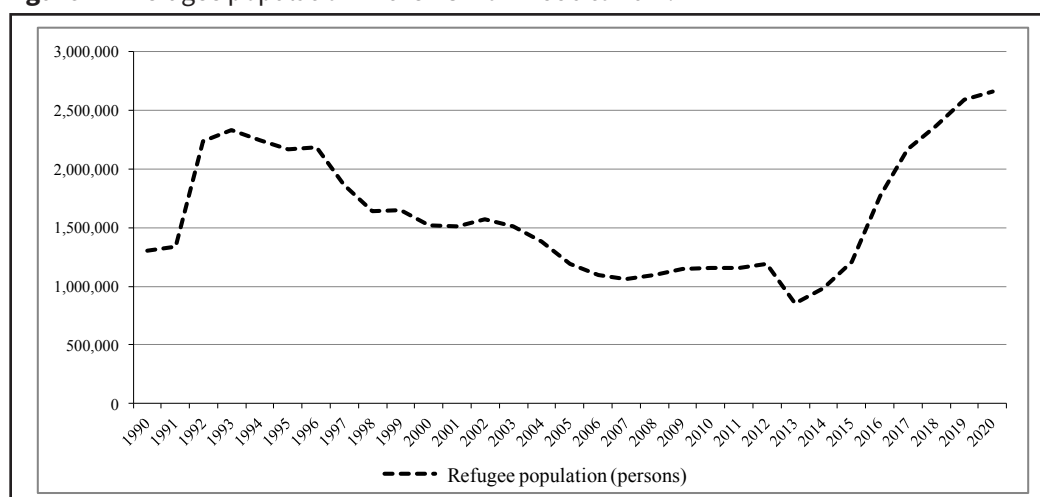
Unlike typical migration flows, refugees' movement represents a special case. The typical migrant moves from his or her origin country not because of a direct threat or persecution, but to improve their standard of living, while a refugee is a person seeking international protection according to the "1951 Convention relating to the Status of Refugees" and its 1967 Protocol. At the level of EU, the "Mutual Learning Programme Peer Review" (European Commission, 2016, p. 2) stipulates that "refugees have the legal right to participate in the labour market on equal terms as native-born residents, and the barriers they face may be of a practical nature." Noteworthy is that in his or her first step to being officially recognized as a refugee, an asylum-seeker has the right to work no later than 9 months after filing the application.

Unfortunately, despite this right, it is very difficult, if not impossible, for a refugee to find a place of work in legal economic activity. Low revenues, language barriers, status as an unskilled worker, culture, religion, or employer reticence are some of the limits in entering the formal labor market.

Therefore, the refugee often prefers to *articulate the official activity with the unofficial one*, or to completely avoid these issues by entering the underground economy. According to Quassoli (1999), the *articulation of the official activity with the unofficial one* can be the result of employment in small- and medium-sized firms in the manufacturing sector (e.g., machinery, textiles, clothing); seasonal jobs, particularly in agriculture; trade activities such as self-employment; service activities including domestic services (i.e., cleaning firms and restaurants); or handicraft activities (e.g., leather goods). The direct preference for the underground economy is related to four types of activities summarized by Mingione and Magatti (1994), cited by Quassoli (1999, p. 213) as tax evasion; activities and transactions forbidden by criminal law; permanent professional activities undertaken outside legal, regulatory or contractual obligations International Labour Organization (ILO); and unpaid economic activities out of direct benefit of the household interest.

The underground economy (shadow economy) is defined by Medina and Schneider (2018) as activities out of official rules being hidden from monetary, regulatory, and institutional perspectives. Thomas (1992) classifies those activities in four sectors: the household sector, the informal sector, the irregular sector, and the criminal sector.

The EU member states give rise to special interest regarding the implications of refugees on the underground economy. Figure 1 reveals the number of refugees in the EU countries between 1990 and 2020. There are two peaks. The first peak is shown in 1993, with >2.4 million

Figure 1 Refugee population in the EU from 1990 to 2017.

Source: Performed based on World Bank (2022a). EU, European Union.

refugees. The Iraqi invasion of Kuwait, the Yugoslav Wars from 1991 to 2001, genocide in Rwanda, and the conflict in Afghanistan are the main explanations of these inflows. After 1993, the number of refugees has continuously decreased, being <1 million people in 2013.

The second peak occurs in 2020, with >2.5 million refugees. The wave started in 2013 and is related to conflicts in several countries, such as Syria, Iraq, Afghanistan, Pakistan, and those in the Horn of Africa and the Sahel. According to the European Commission (2018), in 2015, around 72% of the budget for humanitarian aid (over €1 billion) has been used for helping refugees and internally displaced persons. This exodus generated numerous disputes between the EU member states, especially regarding the country contingents, border protection, and refugees' real status. In parallel, the inflow has been accompanied by illegal immigration, the official control of this phenomenon being a critical problem.

Compared with other migrants, refugees give rise to particular interest related to the underground economy at the level of the EU. Their productivity can be higher if they act in the official economy than in the unofficial one, given the comfort offered by the right to work. The preference for the official economy can also reduce the budget pressure through social allowances, improving at the same time the tax base. In parallel, refusing to act in the underground economy, they can confer more stability and security for host countries, being a disincentive for illegal child labor. Not least, statistical evidence reveals that the share of the refugee population is more strongly correlated with the underground economy than the share of the immigrant population (Table A3 in the Appendix). Despite these particularities, the EU registered different experiences with the officially recognized refugees. Their economic integration depends on how resourceful the person is and/or how open the host society is (Strang and Ager, 2010).

In this context, this paper analyzes the influence of refugees on the size of the underground economy in all the 28 EU countries, over the period from 1998 to 2017. The theoretical grounding of the study is the “structural model” of the underground economy proposed by Medina and Schneider (2018), adjusted for the influence of refugee inflows. The model is inspired by the seminal works of Frey and Weck-Hanneman (1984), followed by Schneider et al. (2010), Hassan and Schneider (2016), and Buehn et al. (2009). The “structural model” of Medina and Schneider (2018) is a part of an extended approach, along with a “measurement model”. The “structural model” investigates the main determinants of the underground

economy, while the measurement model estimates it. The underground economy is explained by the tax burden, the regulatory burden, economic and business freedoms, unemployment, and the level of economic development. The authors claim that economic and business freedom as well as economic development are negatively correlated with the underground economy, while the rest of determinants have positive signs.

Two main theoretical resorts connect refugee inflows with the underground economy, as Williams and Round (2010) claim. The first resort is explained by the “structuralist theory,” while the second is explained by the “neoliberal thesis.” The “structuralist theory” claims the idea of the expulsion of workers from the official labor market (Sassen, 1998; Slavnic, 2010), while the “neoliberal thesis” considers the individual choice as the key of the process, with an emphasis on skilled workers, artisans, and entrepreneurs (Maloney, 2004).

To test the impact of refugee inflows on the size of the underground economy, as well as their implications on Medina and Schneider’s (2018) model, a nonlinear empirical methodology is followed using a dynamic panel threshold strategy similar to that of Kremer et al. (2013), with origins in Hansen (1999). The estimations reveal a nonlinear connection between the share of the refugee population and the informal economy.

The contribution of this paper is threefold. First, to the best of our knowledge, the paper is one of the first studies in the field investigating the “refugees-underground economy” nexus in the case of the EU. Second, as an additional novel contribution, this paper is one of the first studies that follow a nonlinear strategy to investigate the relationship between refugees and the size of the underground economy. Finally, this work offers a new extension of Medina and Schneider’s (2018) model by entering a new determinant for the size of the underground economy: refugee inflows.

The rest of the paper is as follows: Section 2 reviews the literature, while Section 3 describes the data and methodology. Section 4 presents the empirical results. Finally, Section 5 concludes.

2 Literature Review

There is a vast literature regarding the main **determinants of the underground economy**, ranging from social and economic to political and cultural factors. Investigating income tax evasion, the work of Allingham and Sandmo (1972) is considered to be the starting point for underground economy research, although the shadow economy and tax evasion are not congruent concepts. The authors stress that tax compliance is depicted by its related costs and benefits.

Schneider and Buehn (2018) offer a quasi-complete framework of these determinants. Their tabular approach starts with factors such as the tax and social security burden, continuing with institutional quality, regulation, public sector services, tax morale, deterrence, the size of the economy, self-employment and unemployment, and the size of the agricultural sector.

Dell’Anno et al. (2007) claim that a higher tax burden modifies labor-leisure choices, extending the underground economy. Institutional quality seems to be negatively correlated with the underground economy, as an efficient government reduces the size of the informal sector (Williams and Schneider, 2016). Regulations and trade barriers have a positive influence, with more regulations (i.e., low international trade flows) stimulating the underground economy, as Hassan and Schneider (2016) reveal. Furthermore, according to Feld and Schneider (2010), low quality and quantity of public sector services increase the general tax rate, which

extends to the informal sector. Feld and Schneider (2010) also underline that the perceptions toward taxation and strict social norms reduce the shadow economy, while the deterrence in policies combats it. The size of economy is also linked with the informal economy, but opposite in sign, as Williams and Schneider (2016) note. More precisely, an extended official economy is often associated with a small underground one. Self-employment and unemployment are two other essential determinants. Williams and Schneider (2016) argue that rates of self-employment and unemployment are positively correlated with the underground economy. Finally, Hassan and Schneider (2016) find that the agricultural sector also plays an important role. Herein, the possibility of evading the underground economy increases as the agricultural sector expands.

Over the past decades, the literature has started to consider **migration as a new determinant** of the underground economy. The economic effects of immigration are the subject of many papers, most of them being related to the labor market. The distribution effects of migrant inflows related to the native population are one of the most widely investigated topics.

The seminal works in the field can be considered to be the classical models proposed by Todaro, (1969), Fields (1975), Mazumdar (1976), and Lal (1973), treating the underground economy as a temporary outlet for migrants. Further, extensive literature is developed by focusing exclusively on the link between migration flows and the underground economy, with both theoretical and empirical approaches.

For example, Borjas (1994) studied the United States, finding that immigrants are partially responsible for the fall of native earnings during the 1980s. Card (2005) reports a low correlation of local revenues with immigrant density, while D'Amuri and Peri (2014) argue that the inflow of migrants drives natives toward more skill-intensive jobs. Other papers (Borjas, 1998; Bianchi et al., 2012) show that the presence of immigrants is significantly correlated with a higher propensity of committing crimes.

A positive influence of migrant inflows on the underground economy is claimed by Crush et al. (2005) and Landau (2006) in the case of South Africa. They argue that immigration stimulates the underground economy as a result of informational barriers and issues regarding the access to the formal economy. Okkerse (2007) focuses on the case of Organization for Economic Co-operation and Development (OECD) countries, evidencing a bidirectional causality between illegal migration and the shadow economy. She also states that in Ireland, the small inflow of migrants is correlated with a small informal economy. Venturini and Villosio (2008) focus on Italy, but demonstrate that legal immigrants prefer to alternate between regular and irregular jobs. The authors explain that the majority of immigrants access informal jobs because they are better remunerated compared with formal, low-skilled jobs, which are often less stable. Not least, the literature gives special attention to the particular alternatives at the classical underground economy, namely, criminal activities and robberies. For example, Borjas (1998) links U.S. immigrants with criminal activities, while Bianchi et al. (2012) claim that the immigration phenomenon is strongly related to the incidence of robberies. By contrast, Schneider and Badekow (2006) demonstrate that the immigrants escape to underground economy only under severe constraints imposed by public institutions and bureaucratic apparatus.

While it is vast, at the same time it confuses the differences between forced and voluntary migration. Northcote (2015) highlights the fact that there are serious difficulties distinguishing between a refugee (i.e., a forced migrant) and a voluntary migrant, despite the fact that the

refugee claims an independent legal personality (Feller, 2005). Therefore, a frontier approach is invoked by many researchers, such as Friebe et al. (2013), Hunter and Skinner (2003), Landau and Wa Kabwe Segatt (2009), or Vearey (2008).

Finally, a new strand of literature focuses on the impact of **refugee inflows on the underground economy**, offering positive, negative, or neutral evidence. This heterogeneity of outcomes is given across targeted countries or geographical areas, methods of investigation, periods of time analyzed, and dataset frequencies used.

There is an extended literature underlining the **positive link** between refugee inflow on underground economy. For example, the refugee inflows stimulate underground economy for Bracco and Onnis (2016). They confirm the aforementioned outcomes through ordinary least squares (OLS) and two-stage least squares (2SLS) models, invoking a strong connection between migrant inflows and activities in the informal economy. Referring to the EU countries, especially Spain and the United Kingdom (UK), Bovard (2017) stresses that limited positions in the formal economy encourage refugees to choose the informal sector, but only in the short-term. Del Carpio and Wagner (2015) investigate Syrian refugees in Turkey using instrumental variable (IV) estimations. Curiously, their main outcomes support a substitution effect in the informal economy between new arrivals and native workers. This generates an increase in formal employment for Turks, but only in the case of men without a high-school education. Similar findings are obtained by Ceritoglu et al. (2017) by using a difference-in-differences approach. The authors target the same Syrian refugees in Turkey and reveal notable employment losses among informal workers because of refugee inflows. Moreover, the Turkish workers who lost their informal jobs left the labor force or preferred to stay unemployed. Durukan (2015) offers another confirmation of the activities of Syrian refugees in the underground economy. His explanation is related to the temporary protection regime, which does not allow the refugees to work officially.

Altındağ et al. (2020) consider yearly censuses of companies by targeting the case of Syrian refugees in Turkey. They underline that refugee inflows significantly impact the host economy. Many shocks were registered at the level of production and prices, but some engagements of companies in the informal economy were also observed. Moreover, the most affected companies seem to be small ones, as well as those from the construction and hospitality sectors. In the same vein, Berdiev et al. (2020) show that the refugee inflows boost the underground economy preferring cheaper goods and services provided by informal agents. In a very recent paper, Berdiev (2021) claims the same result based on an extended panel with 120 countries, over the years 1991–2017. He finds that the refugee inflows stimulate the size of the underground economy, particularly in low- and middle-income countries. The leading causes are the barriers to entry into the formal labor market, which stimulates the refugees to supply their labor and entrepreneurial skills in the underground economy.

In addition to quantitative analyses, qualitative analyses also validate the preference of refugees for the informal sector. By using such strategies, Erdoğan and Unver (2015) or Erdoğan (2017) show that Syrian refugees accept the low wages offered in the underground economy. Several sectors stand out in this sense: agriculture, construction, manufacturing, and industry services. Other notable works claiming a positive impact of refugees on the underground economy belong to Likic-Brboric et al. (2013), referring to East-Central Europe (including Latvia), Schneider (2016), in the case of Austria, or Nasser and Symansky (2014), for Jordan.

Few papers evidence the **negative impact** of refugees on the underground economy. Altındağ et al. (2020), completing the aforementioned findings, highlight the freedom of movement of capital and the entrepreneurial environment to target geographical areas with large numbers of refugees, overcoming the frontiers. In this way, the refugees' labor force can be absorbed by this new capacity. This result is reinforced by Akgündüz et al. (2018), and Cengiz and Tekguc (2018), who demonstrate that the inflow of refugees stimulates the formal economy by increasing the number of operating companies in the refugee host areas.

No connection between inflows of refugees and the underground economy is found by Sassen (1998) and Jones et al. (2006). Cited by Likic-Brboric et al. (2013), these authors consider that the extension of informal economy in the First World economies is rather related to structural "post-Fordist" changes than the arrival of immigrants and their culture.

Although this literature offers an extended picture regarding the impact of refugees on the underground economy, several research gaps have not been yet or partially been covered appropriately. The first gap is the lack of studies devoted to the case of the EU countries, many of them targeting individual EU countries. The second gap is the lack of empirical papers assuming a nonlinear approach. This strategy is invoked by the existence of a "threshold acceptance reaction" in the destination countries. Therefore, different impact magnitudes of refugees on the underground economy can be expected over time. This elasticity strongly depends on the refugees' behavior, modeled via internal and common EU regulations, climate conditions, the rigidity of markets, or geopolitical contexts.

Given this general literature framework, the paper addresses both gaps mentioned above by offering a complex analysis of the EU's informal economy under the last large exodus in the history of human migration.

3 Data and Methodology

3.1 Dataset

The analysis is performed for 28 EU countries (i.e., Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, and United Kingdom – UK), from 1998 to 2017 (data availability). Therefore, the dataset represents a panel with 28 cross-sections and 20 years ($N > T$).

The **dependent variable** is the size of the underground economy (*und_econ*). The variable is denoted as a percentage of gross domestic product (GDP), revealing the extension of the underground economy compared with the official one. It is taken from Medina and Schneider (2019).

The **variable of interest** is the share of the refugee population, which is a constructed indicator. It represents the number of refugees as a percentage of the total population (*refpop*). Inspired by Altındağ et al. (2020), the variable represents the ratio between the refugee population¹ and the population in the destination country. More precisely, it shows the "balance"

1 We refer to the "refugee population" offered by World Bank (2022a), including "people who are recognized as refugees under the 1951 Convention Relating to the Status of Refugees or its 1967 Protocol, the 1969 Organization of African Unity Convention Governing the Specific Aspects of Refugee Problems in Africa, people recognized as refugees in accordance with the UNHCR statute, people granted refugee-like humanitarian status, and people provided temporary protection. Asylum seekers – people who have applied for asylum or refugee status and who have not yet received a decision or who are registered as asylum seekers – are excluded."

between the newcomers and the native population. Both components, in numbers of persons, are taken from the World Bank (2022a) online database.

Three categories of **control variables** are used to isolate the effect of the variable of interest, being inspired by the “structural model” of the underground economy developed by Medina and Schneider (2018). The first category includes macroeconomic variables, such as the tax burden (*tax*), GDP per capita (*GDPc*), and unemployment (*u*). The second category considers institutional determinants, such as institutional quality (*inst_qual*) and the size of government (*gov*), while a third is focused on trade openness variable (*open*).

Migration and refugee flows can be correlated altering the quality of estimation. On the one hand, several pull factors are almost the same, and on the other hand, the common migration routes are intensively used by both illegal migrants and asylum seekers. To tackle this issue, in addition to Medina and Schneider’s (2018) model, the share of immigrant population variable (*im_pop*) is considered in order to control for migration flow. The variable denotes total immigrants as a percentage of the population in the destination country. In this way, the effect of *refpop* on *und_econ* is better isolated in respect to *im_pop*. The number of immigrants is reported by the Eurostat (2022) online database, while the population is taken from the World Bank (2022a) online database. According to the literature, we expect both negative and positive signs for this variable.

Detailed information about the variables and their expected signs is presented in Table A1 in the Appendix, according to Medina and Schneider’s (2018) model. All variables are treated in percentages, so the marginal effect in a regression estimates their elasticities. The only exceptions are *GDPc*, which appears in its natural logarithm form; and *inst_qual*, which is expressed as an index.

3.2 Methodology

This study of the impact of refugees on the underground economy of the EU follows a non-linear analysis by using a threshold panel approach, which covers the period from 1998 to 2017. The reason for this assumption is given by the fact that the biological, natural, and social processes generally follow a nonlinear dynamic, with the birth rates and coefficients of interaction between the populations being the main explanations, as Jordanov and Nikolova (2013, p. 69) note.

A large number of refugees represent a serious challenge for receiving countries, which must involve additional financial and human resources to face. In this context, we assume the existence of a refugee’s thresholds generated by disturbances in the management of the reception and integration processes. Therefore, such “critical” levels have deep implications in the informal economy, as the related literature shows. It “describes the jumping character or structural break” (Wang, 2015) in connection to the refugees with the underground economy.

As consequence, the “structural model” of the underground economy of Medina and Schneider (2018), with an extension to incorporate refugees, is empirically tested using Hansen’s (1999) tool in its improved version developed by Kremer et al. (2013). This methodology assumes threshold effects in non-dynamic panels. Such models have several advantages, as Pan et al. (2016) highlight: there is no need for nonlinear equations, the identified thresholds are endogenous, the confidence interval of parameters follow asymptotic distribution, and

the statistical significance is based on bootstrap routines. The country-specific effects are also taken into account.

Assuming thresholds in the share of the refugee population (*refpop*), the single-threshold model has the following form:

$$\begin{aligned} und_econ_{it} = & \alpha_0 + \alpha_{11}refpop_{it}(refpop_{it} \leq \gamma) + \alpha_{12}refpop_{it}(refpop_{it} \geq \gamma) + \beta_1tax_{it} + \beta_2ln(GDPc)_{it} \\ & + \beta_3u_{it} + \beta_4inst_qual_{it} + \beta_5gov_{it} + \beta_6open_{it} + \beta_7im_pop_{it} + \beta_8und_econ_{it-1} + v_i + \varepsilon_{it} \end{aligned} \quad (1)$$

where *refpop* is the threshold variable, γ denotes the threshold parameter which divides the equation into two regimes with coefficients $\alpha_{11,12}$, α_0 is the constant, v_i stands for individual effects related to country *i*, while ε_{it} captures the disturbance at time *t*. β_{1-7} are the coefficients of control variables.

The double-threshold model is as follows:

$$\begin{aligned} und_econ_{it} = & \alpha_0 + \alpha_{11}refpop_{it}(refpop_{it} \leq \gamma_1) + \alpha_{12}refpop_{it}(\gamma_1 < refpop_{it} \leq \gamma_2) \\ & + \alpha_{13}refpop_{it}(refpop_{it} \geq \gamma_2) + \beta_1tax_{it} + \beta_2ln(GDPc)_{it} + \beta_3u_{it} + \beta_4inst_qual_{it} \\ & + \beta_5gov_{it} + \beta_6open_{it} + \beta_7im_pop_{it} + \beta_8und_econ_{it-1} + u_i + \varepsilon_{it} \end{aligned} \quad (2)$$

where $\gamma_{1,2}$ represent the threshold parameters that divide the equation into three regimes with coefficients $\alpha_{11,12,13}$.

The estimation of thresholds is performed by assuming that the sequential estimator is consistent, as Bai (1997) and Bai and Perron (1998) note. Therefore, according to Wang (2015), three main steps depict this procedure:

Step 1: The estimation of the single-threshold model, in order to fit the parameter γ_1 and the residual sum of squares (RSS) as $S_1(\hat{\gamma}_1)$.

Step 2: The estimation of the second threshold and its related confidence interval, based on $\hat{\gamma}_1$:

$$\hat{\gamma}_2^r = \arg \min_{\gamma_2} \{S_2^r(\gamma_2)\} \quad (3)$$

$$S_2^r S = \{ \min(\hat{\gamma}_1, \gamma_1) \max(\hat{\gamma}_1, \gamma_2) \} \quad (4)$$

$$LR_2^r(\gamma_2) = \frac{\{S_2^r(\gamma_2) - S_2^r(\hat{\gamma}_2^r)\}}{\hat{\sigma}_{22}^2}, \quad (5)$$

where likelihood ratio (LR) is the LR statistic and σ^2 denotes the variance.

Step 3: Re-estimation of the first threshold, given that $\hat{\gamma}_2^r$ is efficient while $\hat{\gamma}_1^r$ is not:

$$\hat{\gamma}_1^r = \arg \min_{\gamma_1} \{S_1^r(\gamma_1)\} \quad (6)$$

$$S_1^r S = \{ \min(\gamma_1, \hat{\gamma}_2) \max(\gamma_1, \hat{\gamma}_2) \} \quad (7)$$

$$LR_1^r(\gamma_1) = \frac{\{S_1^r(\gamma_1) - S_1^r(\hat{\gamma}_1^r)\}}{\hat{\sigma}_{21}^2}. \quad (8)$$

Testing for threshold effects means checking whether the coefficients are the same in each regime or not. Herein, two sequences are followed: the first discriminates between the linear and the single-threshold model, while the second compares the single- with the double-threshold model.

In the first sequence, the null hypothesis of no threshold effect (linear model) or the alternative one of threshold effect (nonlinear model) are:

$$H_0 = \alpha_{11} = \alpha_{12} \text{ or } H_a = \alpha_{11} \neq \alpha_{12}, \quad (9)$$

with an F -statistic calculated as:

$$F_1 = \frac{(S_0 - S_1)}{\hat{\sigma}^2}. \quad (10)$$

If the null hypothesis is rejected in the simple-threshold model, the double-threshold estimator is further checked, according to a new F -statistic, calculated as follows:

$$F_2 = \frac{\{S_1(\hat{\gamma}_1) - S_2(\hat{\gamma}_2)\}}{\hat{\sigma}_{22}^2}. \quad (11)$$

According to Nguyen and To (2016), in the double-threshold model, the null hypothesis tests the existence of one or two thresholds. If the null hypothesis is rejected, then the double-threshold model is more appropriate. Further, the process is similar for the models with more than two thresholds.

The refugees represent a special case of migrants who leave their countries seeking international protection. Often this desiderata is overlapped with many other classical pull factors, such as the underground economy (Talani, 2019). Hence, a potential endogeneity issue by reverse causality type can arise between the share of the refugee population and the underground economy. More precisely, the share of the refugee population can influence the size of the underground economy but also the underground economy can act as a pull factor for the refugee flow. Moreover, several other variables can be suspected by endogeneity through the reverse impact of the underground economy on them, generating bias in estimations: *tax* (Kodila-Tedika and Mutascu, 2014); *ln(GDPc)*, *u*, and *gov* (Schneider and Enste, 2000); or *im_pop* (Talani, 2019).

To deal with any endogeneity concerns, the estimations are conducted by using an improved version of Hansen's (1999) tool proposed by Kremer et al. (2013)². This approach supposes a dynamic panel threshold estimator which allows to consider threshold effects in panel data even in the case of endogenous regressors. The used instruments are the lagged endogenous variables, including *refpop* threshold interest determinant. The LR statistic of selected threshold is also employed considering all determinants.

Working with many explanatory variables, the variance inflation factors (VIF) test and matrix of correlation offer support to detect possible multicollinearity. The robustness check is done by sequentially entering the control determinants in the constructed models.

4 Results

By using the threshold dynamic panel method proposed by Kremer et al. (2013), a set of models offers the results supporting the main interpretations and conclusions.

As the **first step** of analysis, the VIF tests for detecting multicollinearity are performed by considering all determinants. The results are provided in Table A2 in the Appendix. These

² The estimations are performed based on STATA code freely offered by Diallo (2020).

clearly show that the variables used in the regressions are moderately correlated, as all test values are below the critical level of 5, as Ringle et al. (2015) suggest. The results are reinforced by the correlation matrix in Table A3 in the Appendix. All coefficients of correlation are lower than the critical level of 0.9 recommended by Hall and Asteriou (2011, p. 101).

The **second step** of the study involves checking for threshold effects by discriminating between linear and nonlinear estimations, with a single threshold, double thresholds, and triple thresholds. Table A4 in the Appendix shows the main findings of the tests for threshold effects. A bootstrap routine approximates the F -statistic and related p -value by using 300 bootstrap replications.

The output clearly reveals that the null hypothesis of linear estimation (i.e., no threshold effect) is rejected at the 10% level of significance; the F_1 test for a single threshold model is 22.97, with a p -value of 0.006. Hence, the single threshold model is more appropriate than the linear one. Furthermore, both F_2 (with a p -value of 0.160) and F_3 (p -value of 0.200) tests for double and triple thresholds denote that the single threshold model is more efficient. Therefore, the single threshold estimator is preferred to the linear and multiple threshold ones.

The **third step** is reserved for performing the models in order to describe the impact of the share of refugee population on the underground economy. Table A5 in the Appendix present the main findings, while Figure A1 in the Appendix shows the LR statistic.

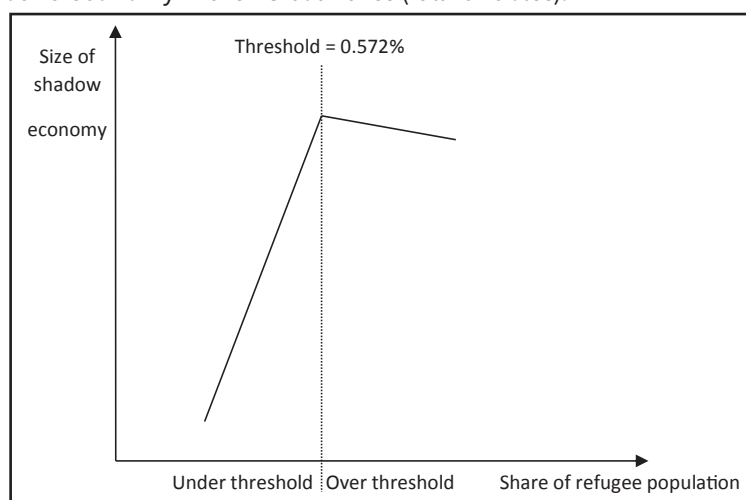
The outcomes reveal that both threshold *refpop* regime coefficients are significant but with opposite signs in all models (1–7). The first regime coefficient (i.e., under threshold) is positive, while the second regime coefficient (i.e., over threshold) is negative. In all cases, the threshold *refpop* regime coefficients are robust under different choices of determinants, reinforcing the quality of estimations.

The control variables are significant in all estimations, with the exception of the tax burden, institutional quality, and the size of the government. Per-capita GDP, unemployment, trade openness, and the share of the immigrant population are negatively correlated with the size of the underground economy. The findings partially confirm the results of Medina and Schneider (2018), as the unemployment rate has the opposite sign in respect to the expected one. The negative link between unemployment and the underground economy aligns with Gora et al. (2009). A generous unemployment allowance can offer a comfortable standard of living, stimulating the employment in the official labor market given the attraction of social security benefits. The negative sign of the share of the immigrant population in respect to the underground economy does not confirm the mainstream literature (e.g., Crush et al., 2005; Landau, 2006; Bracco and Onnis, 2016; Venturini and Villosio, 2008). This is in accord with Schneider and Badekow (2006), who claim that permissive constraints created by public institutions and bureaucratic apparatus can be a significant disincentive for immigrants to access the underground economy.

Not least, the significance and positive sign of a lagged underground economy reinforce the idea that the underground economy exhibits a short-memory process in the EU countries. More precisely, the current underground economy depends on its past dynamic (e.g., a positive past change of underground economy stimulates its current level probably because of “permissive” signals come from the market).

For the full Model (7), the threshold regime coefficients have values of 239.3 and -0.826 , respectively. The estimated threshold is 0.00572, meaning that refugees make up 0.572% of

Figure 2 The threshold effect of the share of refugee population on the size of the underground economy in the EU countries (full variables).



the total population in the receiving country. Herein, the increase in the share of the refugee population has a nonlinear effect on the underground economy, with different signs and slopes impacts, as Figure 2 shows.

Figure 2 illustrates that the increase in the share of the refugee population strongly boosts the underground economy until a peak after that slightly falls. More precisely, the inflow of refugees stimulates the underground economy at a low level of contingents (i.e., LR statistic in Figure A1 in Appendix reveals a low threshold level), contracting it as soon as a critical point is overcome.

The results confirm Maloney's (2004) vision, where an asymmetrical effect of the share of the refugee population on the underground economy is an adaptation issue rather than a barrier one. The positive slope is in line with Altındağ et al. (2020), Berdiev et al. (2020), or Berdiev (2021), while the negative effect reinforces the results of Akgündüz et al. (2018), or Cengiz and Tekguc (2018).

The study is limited by the data availability; further research targeting the extension of the panel in terms of the period can be performed as soon as the new dataset is officially available.

5 Conclusion

This study explores the impact of refugees on the size of the underground economy in all 28 EU countries, for the period 1998–2017, using a dynamic panel threshold approach. The main results uncover a nonlinear link between refugee inflows and the size of the underground economy following an inverted V-shape, with its magnitude depending on the level of the share of the refugee population.

The positive impact of refugees on the underground economy under the threshold suggests a sort of labor market rigidity in the absorption of refugee inflows even under good macroeconomic context. Herein, as the labor supply does not significantly increase, competition in the labor market is still low, which does not reduce labor costs. This encourages the refugees to prefer the underground economy to the detriment of the official one in terms of both labor and consumption (i.e., lower prices).

With large refugee contingents, the labor market slowly adapts in demand, with supply becoming very generous at lower labor costs. In parallel, growth and international trade can support this process, expanding the economy. New labor and entrepreneurial opportunities arise in this case for newcomers, stimulating consumption in the official market. As a consequence, the budgetary constraint relaxes, counteracting any unemployment allowance pressure. This can open the door for better regulation of other immigrants, finally helping regulated persons to act in the official economy.

Several policy implications can be identified. Accepting a high number of refugees, EU policymakers must control the underground economy by maintaining economic growth and international trade flows. Special attention must be paid when refugee contingents are small. Budgetary policy requires decent unemployment allowances to counteract the propensity of jobless persons to escape into the underground economy. The past dynamic of underground economic activity seems helpful to anticipate future activity, while illegal immigration should be strictly controlled.

Declarations

Availability of data and material

Not applicable.

Competing interests

Not applicable.

Funding

Not applicable.

Authors' contributions

Mutascu Mihai: Dataset collection, Methodology, Estimations, Findings, Conclusions. Hegerty Scott: Introduction, Literature, Findings, Conclusions.

Acknowledgements

The authors thank the editor and anonymous referees very much for their useful comments and suggestions, helping to substantially improve the quality of the paper.

References

- Akgündüz, Y. E.; M. Van den Berg; W. Hassink (2018): The Impact of the Syrian Refugee Crisis on Firm Entry and Performance in Turkey. *World Bank Economic Review* 32(1), 19-40.
- Allingham, M.; A. Sandmo (1972): Income Tax Evasion: A Theoretical Analysis. *Journal of Public Economics* 1(3-4), 323-338.
- Altındağ, O.; O. Bakis; S. Roza (2020): Blessing or Burden? The Impact of Refugees on Businesses and the Informal Economy. *Journal of Development Economics* 40, 102490.
- Bai, J. (1997): Estimating Multiple Breaks One at a Time. *Econometric Theory* 13, 315-352.
- Bai, J.; P. Perron (1998): Estimating and Testing Linear Models with Multiple Structural Changes. *Econometrica* 66, 47-78.
- Becker, S. O.; A. Ferrara (2019): Consequences of Forced Migration: A Survey of Recent Findings. *Labour Economics* 59, 1-16.
- Berdiev, A. N. (2021): Finding Refuge Underground: Effects of Refugee Inflows on the Shadow Economy. *Applied Economics Letters*, doi: 10.1080/13504851.2021.1976379.
- Berdiev, A. N.; J. W. Saunoris; F. Schneider (2020): Poverty and the Shadow Economy: The Role of Governmental Institutions. *The World Economy* 43(4), 921-947.
- Bianchi, M.; P. Buonoanno; P. Pinotti (2012): Do Immigrants Cause Crime?" *Journal of the European Economic Association* 10(6), 1318-1347.
- Borjas, G. J. (1994): The Economics of Immigration. *Journal of Economic Literature* 32(4), 1667-1717.

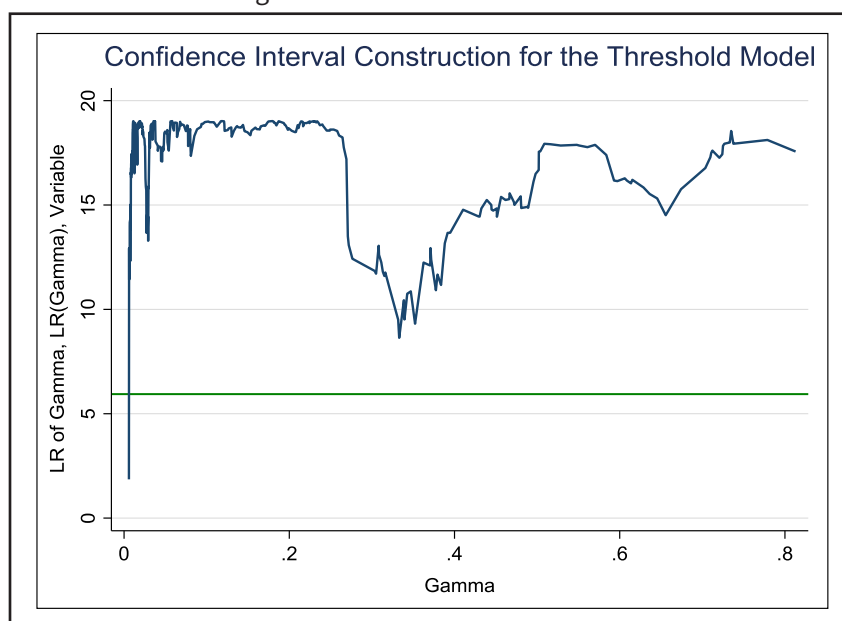
- Borjas, G. J. (1998): To Ghetto or Not to Ghetto: Ethnicity and Residential Segregation. *Journal of Urban Economics* 44(2), 228-253.
- Bovard, M. K. (2017): *The Economics of Refugees: How Refugees Influence the Economies of Spain and England*. Student Publications, 546. https://cupola.gettysburg.edu/student_scholarship/546
- Bracco, E.; L. Onnis (2016): Immigration, amnesties and the shadow economy, No 108263550, Working Papers, Lancaster University Management School, Economics Department, <https://EconPapers.repec.org/RePEc:lan:wpaper:108263550>.
- Buehn, A.; A. Karmann; F. Schneider (2009): Shadow Economy and Do-it-Yourself Activities: The German Case. *Journal of Institutional and Theoretical Economics*. 165(4), 701-722.
- Card, D. (2005): Is the New Immigration Really so Bad? *Economic Journal* 115(507), F300-F323.
- Cengiz, D.; H. Tekguc (2018): Is it Merely a Labor Supply Shock? Impacts of Syrian Migrants on Local Economies in Turkey. Political Economy Research Institute, Mimeo.
- Ceritoglu, E.; H. B. Yunculer; H. Torun; S. Tumen (2017): The Impact of Syrian Refugees on Natives Labor Market Outcomes in Turkey: Evidence from a Quasi-experimental Design. *IZA Journal of Labor Policy* 6(1), 5.
- Crush, J.; V. Williams; S. Peberdy (2005): Migration in Southern Africa, Working Paper, Policy Analysis and Research Programme of the Global Commission on International Migration. 2005/9.
- D'Amuri, F.; G. Peri (2014): Immigration, Jobs, and Employment Protection: Evidence from Europe Before and During the Great Recession. *Journal of the European Economic Association* 12(2), 432-464.
- Del Carpio, X. V., ; M. Wagner, M., (2015,): "The Impact of Syrian Refugees on the Turkish Labor Market", . Policy Research Working Paper, 7402.
- Dell'Anno, R. (2007): The Shadow Economy in Portugal: An Analysis with the MIMIC Approach. *Journal of Applied Economics* 10, 253-277.
- Diallo, I. A. (2020): XTENDOTHRSDPD: Stata Module to Estimate a Dynamic Panel Data Threshold Effects Model with Endogenous Regressors. Statistical Software Components S458745, Boston College Department of Economics, revised 18 Apr 2020.
- Durukan, O. (2015): Country Report: Turkey. European Council of Refugees and Exiles.
- Erdoğan, M. (2017): Urban Refugees From "Detachment" to "Harmonization" Syrian Refugees and Process Management of Municipalities: The Case of Istanbul. *Marmara Belediyeler Birliği*.
- Erdoğan, M.; C. Unver (2015): Perspectives, Expectations and Suggestions of the Turkish Business Sector on Syrians in Turkey. Turkish Confederation of Employer Associations.
- European Commission (2016): Mutual Learning Programme Peer Review on 'Labour market inclusion of international protection applicants and beneficiaries', 23-24 May 2016, Madrid (Spain).
- European Commission (2018): Refugees and Internally Displaced. https://ec.europa.eu/echo/what/humanitarian-aid/forced-displacement-refugees-asylum-seekers-and-internally-displaced-people-idps_en
- Eurostat (2022): Eurostat online database. 4 February 2021, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Migration_and_migrant_population_statistics
- Feld, L.; F. Schneider (2010): Survey on the Shadow Economy and Undeclared Earnings in OECD Countries. *German Economic Review* 11(2), 109-149.
- Feller, E. (2005): Refugees are not Migrants. *Refugee Survey Quarterly* 24(4), 27-35.
- Fields, G. S. (1975): Rural-urban Migration, Urban Unemployment and Underemployment, and Job-search Activity in LDCs. *Journal of Development Economics* 2(2), 165-187.
- Frey, B. S.; H. Weck-Hanneman (1984): The Hidden Economy as 'Unobserved Variable'. *European Economic Review* 26, 33-53.
- Friebel, G.; J. M. Gallego; M. Medola (2013): Xenophobia Attacks, Migration Intentions, and Networks: Evidence from the South of Africa. *Journal of Population Economics* 26(2), 555-591.
- Gora, M.; O. Rohozynsky; I. Sinitsina; M. Walewski (2009): Social Security Driven Tax Wedge and Its Effects on Employment and Shadow Employment. CASE Network Studies and Analyses 0398. CASE-Center for Social and Economic Research.
- Hall, S.; D. Asteriou (2011): *Applied Econometrics*, Second Edition, London: Palgrave Macmillan.
- Hansen, B. E. (1999): Threshold Effects in Non-dynamic Panels: Estimation, Testing, and Inference. *Journal of Econometrics* 93, 345-368.
- Hassan, M.; F. Scheider (2016): Size and Development of the Shadow Economies of 157 Worldwide Countries: Updated and New Measures from 1999 to 2013. *Journal of Global Economics* 4(3), 14.
- Hunter, N.; C. Skinner (2003): Foreign Street Traders Working in Inner City Durban: Local Government Policy Challenges. *Urban Forum* 14, 301-319.
- Jones, T.; M. Ram; P. Edwards (2006): Shades of Grey in the Informal Economy. *International Journal of Sociology and Social Policy* 26(9/10), 357-373.

- Jordanov, I.; E. Nikolova (2013): On Nonlinear Waves in the Spatio-Temporal Dynamics of Interacting Populations. *Journal of Theoretical and Applied Mechanics* 43(2), 69-76.
- Kodila-Tedika, O.; M. Mutascu (2014): Shadow Economy and Tax Revenue in Africa. *Economics Bulletin* 34(1), 469-479.
- Kremer, S.; A. Bick; D. Nautz (2013): Inflation and Growth: New Evidence from a Dynamic Panel Threshold Analysis. *Empirical Economics* 44, 861-878.
- Lal, D. (1973): Disutility of Effort, Migration and the Shadow Wage Rate. *Oxford Economic Papers* 25, 112-126.
- Landau, L. (2006): Protection and Dignity in Johannesburg: Shortcomings of South Africa's Urban Refugee Policy. *Journal of Refugee Studies* 19(3), 308-327.
- Landau, L.; A. Wa Kabwe Segatti (2009): Human Development Impacts of Migration: South Africa Case Study. Human Development Research Paper No. 2009/05.
- Likic-Brbori, B.; Z. Slavnic; C. Woolfson (2013): Labour Migration and Informalisation: East Meets West. *International Journal of Sociology and Social Policy* 33(11/12), 677-692.
- Maloney, W. F. (2004): Informality Revisited. *World Development* 32(7), 1159-1178.
- Mazumdar, D. (1976): The Rural-urban Wage Gap, Migration and the Shadow-wage. *Oxford Economic Papers* 28(3), 406-425.
- Medina, L.; F. Schneider (2018): Shadow Economies Around the World: What Did We Learn Over the Last 20 Years? IMF Working paper, WP/18/17.
- Medina, L.; F. Schneider (2019): Shedding Light on the Shadow Economy: A Global Database and the Interaction with the Official One. CESifo Working Paper No. 7981.
- Mingione, E.; M. Magatti (1994): The Informal Sector. Follow-up to the White Paper, Mimeo.
- Nasser, R.; S. Symansky (2014): The Fiscal Impact of the Syrian Refugee Crisis on Jordan. USAID, Jordan Fiscal Reform II Project.
- Nguyen, T. O.; N. K. To (2016): Threshold Effect in the Relationship Between Foreign Direct Investment and Economic Growth: Evidence from ASEAN Countries. Asia Pacific Institute of Advanced Research (APIAR), Third Asia Pacific Conference on Advanced Research (APCAR, Melbourne, July), 32-45.
- Northcote, M. A. (2015): Enterprising Outsiders: Livelihood Strategies of Cape Town's forced migrants. Electronic Thesis and Dissertation Repository. 2806.
- Okkerse, L. (2007): Migration and the Shadow Economy. Discussion paper, UCSIA DP N° 0701.
- Pan, X.; Y. Yan; X. Peng; Q. Liu (2016): Analysis of the Threshold Effect of Financial Development on China's Carbon Intensity. *Sustainability* 8(271), 1-14.
- Quassoli, F. (1999): Migrants in the Italian Underground Economy. *International Journal of Urban and Regional Research* 23(2), 212-231.
- Ringle, C. M.; S. Wende; J. M. Becker (2015): SmartPLS 3. Bönningstedt: SmartPLS. <http://www.smartpls.com>
- Sassen, S. (1998): *Globalization and Its Discontents. Essays on the New Mobility of People and Money.* New York: New Press.
- Schneider, F. (2016): Shadow Economy in Austria - the Latest Developments up to 2016. Johannes Kepler University Linz, Mimeo.
- Schneider, F.; H. Badekow (2006): Ein Herz für Schwarzarbeiter: Warum die Schattenwirtschaft unseren Wohlstand steigert. Berlin: Econ/ullstein Buchverlag.
- Schneider, F.; A. Buehn (2018): Shadow Economy: Estimation Methods, Problems, Results and Open questions. *Open Economics* 1, 1-29.
- Schneider, F.; A. Buehn; C. E. Montenegro (2010): New Estimates for the Shadow Economies all over the World. *International Economic Journal* 24(4), 443-461.
- Schneider, F.; D. H. Enste (2000): Shadow Economies: Size, Causes, and Consequences. *Journal of Economic Literature* 38(1), 77-114.
- Slavnic, Z. (2010): Political Economy of Informalization. *European Societies* 12(1), 3-23.
- Strang, A.; A. Ager (2010): Refugee Integration: Emerging Trends and Remaining Agendas. *Journal of Refugee Studies* 23(4), 589-607.
- Talani, L. S. (2019): Assessing the Relation Between the Underground Economy and Irregular Migration in Italy. *The International Spectator (Istituto Affari Internazionali)* 54(2), 102-122.
- Thomas, J. (1992): *Informal Economic Activity, London School of Economics Handbooks in Economics,* London.
- Todaro, M. P. (1969): A Model of Labour Migration and Urban Unemployment in Less Developed Countries. *American Economic Review* 69, 486-499.
- Vearey, J. (2008): Migration, Access to ART, and Survivalist Livelihood Strategies in Johannesburg. *African Journal of AIDS Research* 7(3), 361-374.

- Venturin, A.; C. Villosio (2008): Labour-market Assimilation of Foreign Workers in Italy. *Oxford Review of Economic Policy* 24(3), 517-541.
- Verme, P.; K. Schuettler (2021): The Impact of Forced Displacement on Host Communities: A Review of the Empirical Literature in Economics. *Journal of Development Economics* 150, 102606.
- Wang, Q. (2015): Fixed-Effect Panel Threshold Model Using Stata. *Stata Journal* 15, 121-134.
- Williams, C.; J. Round (2010): Explaining Participation in Undeclared Work. *European Societies* 12(3), 391-418.
- Williams, C. C.; F. Schneider (2016): *Measuring the Global Shadow Economy: The Prevalence of Informal Work and Labour*. Edward Elgar Publishing, UK.
- World Bank (2022a): World Development Indicators online database.
- World Bank (2022b): Worldwide Governance Indicators online database.

Appendix

Figure A1 LR statistic of a single threshold model.



Notes: The dashed line shows the critical value at the 95% confidence level. LR, likelihood ratio.

Table A1 Description of variables and their expected signs

Variables	Explanation	μm	Source	Expected sign
Underground economy (<i>und_econ</i>) – dependent variable	Level of underground economy as percentage of GDP.	%	Schneider (2016), Medina and Schneider (2018).	
Share of refugee population (<i>refpop</i>) – interest variable	Refugee population as percentage of population in destination country.	%	World Bank (2022a).	\pm
Controls:				
Tax burden (<i>tax</i>)	Tax revenues as percentage of GDP.	%	World Bank (2022a).	+
GDPc	GDPc (constant 2015 US\$).	US\$	World Bank (2022a).	-
Unemployment (<i>u</i>)	Total of unemployed persons as percentage of total labor force.	%	World Bank (2022a).	+
Institutional quality (<i>inst_qual</i>)	Captured as Rule of Law indicator, with range goes from -2.5 (weak) to 2.5 (strong) governance performance.	Index	World Bank (2022b).	-
Size of government (<i>gov</i>)	Volume of government expenses as percentage of GDP.	%	World Bank (2022a).	-
Trade openness (<i>open</i>)	Volume of imports plus exports as percentage of GDP.	%	World Bank (2022a).	-
Share of immigrant population (<i>im_pop</i>)	Total immigrants as percentage of population in destination country.	%	Eurostat (2022).	\pm

GDPc, GDP per capita; GDP, Gross Domestic Product.

Table A2 VIF test results for multi-collinearity detection

Variable	VIF	1/VIF
<i>inst_qual</i>	4.44	0.225386
<i>ln(GDPc)</i>	4.38	0.228526
<i>Tax</i>	2.72	0.36749
<i>gov</i>	2.39	0.418921
<i>im_pop</i>	1.68	0.596614
<i>open</i>	1.47	0.679514
<i>refpop</i>	1.41	0.709888
<i>u</i>	1.38	0.723129
Mean VIF	2.48	

GDPc, GDP per capita; GDP, gross domestic product; VIF, variance inflation factors.

Table A3 Matrix of correlation

Variable	<i>und_econ</i>	<i>refpop</i>	<i>tax</i>	<i>ln(GDPc)</i>	<i>u</i>	<i>inst_qual</i>	<i>gov</i>	<i>open</i>	<i>im_pop</i>
<i>und_econ</i>	1								
<i>refpop</i>	-0.391	1							
<i>tax</i>	-0.013	0.231	1						
<i>ln(GDPc)</i>	-0.799	0.449	0.299	1					
<i>u</i>	0.325	-0.293	-0.288	-0.411	1				
<i>inst_qual</i>	-0.782	0.494	0.305	0.865	-0.453	1			
<i>gov</i>	0.143	-0.051	0.700	-0.016	-0.025	0.029	1		
<i>open</i>	-0.102	0.159	0.270	0.212	-0.256	0.188	0.200	1	
<i>im_pop</i>	-0.198	0.234	0.344	0.404	-0.290	0.338	0.173	0.543	1

GDPc, GDP per capita; GDP, gross domestic product.

Table A4 Tests for threshold effects

Test for single threshold	
F_1	22.97***
p -value	0.0067
(10%, 5%, 1% critical value)	(13.0142; 14.8043; 19.9052)
Test for two thresholds	
F_2	9.58
p -value	0.1600
(10%, 5%, 1% critical value)	(10.8853; 14.6780; 20.4151)
Test for triple thresholds	
F_3	9.45
p -value	0.2000
(10%, 5%, 1% critical value)	(12.9204; 16.9980; 27.0286)

Notes: *, **, *** denote significance at 10%, 5% and 1% level, respectively.

Table A5 Results of single threshold models

Dependent variable: underground economy (<i>und_econ</i>)							
Models	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimated threshold	0.00572	0.00572	0.00572	0.00572	0.00572	0.00572	0.00572
Lower	0.00572	0.00572	0.00572	0.00572	0.00572	0.00572	0.00572
Upper	0.00589	0.00589	0.00589	0.00589	0.00589	0.00589	0.00589
<i>refpop</i> – first regime coefficient (α_{11})	226.3*** (51.11)	345.9*** (86.92)	285.2*** (48.28)	224.8*** (57.01)	326.8*** (66.39)	239.5*** (55.23)	239.3*** (57.52)
<i>refpop</i> – second regime coefficient (α_{12})	-0.978*** (0.266)	-0.951*** (0.331)	-0.622*** (0.219)	-0.792*** (0.267)	-0.946*** (0.243)	-0.974*** (0.235)	-0.826*** (0.288)
Control variables							
<i>constant</i>	40.44*** (3.896)	6.654*** (1.709)	8.196*** (1.513)	40.83*** (3.621)	11.11*** (1.429)	25.38*** (6.497)	27.21*** (6.176)
<i>tax</i>	-0.011 (0.008)			-0.064** (0.027)		-0.026** (0.011)	-0.059* (0.031)
<i>ln(GDPc)</i>	-3.292*** (0.382)			-3.299*** (0.391)		-1.561*** (0.699)	-1.751*** (0.663)
<i>u</i>	-0.058*** (0.013)			-0.091*** (0.023)		-0.037** (0.014)	-0.065** (0.026)
<i>inst_qual</i>		-2.225** (0.939)		-0.291 (0.718)	-0.866 (0.822)		-0.369 (0.663)
<i>gov</i>		0.015 (0.011)		0.038* (0.021)	0.004 (0.011)		0.027 (0.021)
<i>Open</i>			-0.021*** (0.005)		-0.022*** (0.004)	-0.014** (0.005)	-0.011** (0.004)
<i>im_pop</i>			-0.352*** (0.131)		-0.489*** (0.141)	-0.368** (0.143)	-0.364** (0.143)
<i>lag(und_econ)</i>	0.663*** (0.027)	0.753*** (0.061)	0.708*** (0.049)	0.656*** (0.027)	0.641*** (0.038)	0.651*** (0.029)	0.659*** (0.028)
Wald χ^2	3,399.1 Pr.=0.000	1,565.5 Pr.=0.000	1,062.8 Pr.=0.000	7,305.4 Pr.=0.000	2,287.3 Pr.=0.000	5,389.2 Pr.=0.000	8,689.12 Pr.=0.000
Number of observations	532	532	532	532	532	532	532
Number of groups	28	28	28	28	28	28	28

Notes: *, **, *** denote significance at 10%, 5%, and 1% level, respectively;

(...) denotes the standard error.

GDPc, GDP per capita; GDP, gross domestic product.