The nexus between unemployment rate and shadow economy: a comparative analysis of developed and developing countries using a simultaneous-equation model

Marwa Sahnoun and Chokri Abdennadher

Abstract

This paper studies the effects and causal links between the shadow economy and the unemployment rate using a dynamic simultaneous-equation panel data model for 38 developing and 40 developed countries over the 2000–2015 period. The analysis suggests that there is a unidirectional and negative causality running from the unemployment rate to the shadow economy in the developing countries. However, in the developed countries, there is a bidirectional and negative causal relationship between the shadow economy and unemployment rate. The sensitivity of the results makes the authors realize that institutional quality interacts strongly with the relationship between the shadow economy and the unemployment rate. In countries with a good institutional quality, the unemployment rate is associated with a weak informal economy, whereas in countries with low institutional quality, it strongly drives the informal economy.

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Introduction

The nexus between the unemployment and the shadow economy remains one of the most important issues in the economic literature. In recent years, policy makers have required improved interest for this relationship in the developing and developed countries. The shadow economy and the unemployment rate play an important role in the developing and developed economies. Schneider (2008) and Smith et al., (1985) also contributed to the definition of the informal sector. Indeed, Schneider (2008) showed that the informal sector is all activities currently unrecorded economies that contribute to GNP officially calculated or observed. As for Smith et al., (1985), the informal sector is defined as the market-driven production of goods and services, either legal or illegal. Thus, economic activities and income from informal activities are described as all the transactions that circumvent or escape government regulation, taxation, and compliance. Evidence has shown that in general, the nature of the relationship between the shadow economy and the unemployment rate remains controversial (Tanzi, 1999; Tedds and Giles, 2002; Dell'Anno et al., 2007). It has been showed that high levels of unemployment tend to have a higher share of the informal economy in total GDP (Boeri and Garibaldi, 2002; Dell'Anno and Solomon, 2008; Dobre et al., 2010; Alexandru et al., 2010; Davidescu et al., 2015; Mauléon and Sardà, 2017), the growth in the number of unemployed persons could lead to the decrease of the number of people who are involved in the informal sector (Tedds and Giles, 2002) while the informal economy could be positively related to the GDP growth rate which in turn is negatively correlated with unemployment (Saafi et al., 2015).

Moreover, several authors (Johnson et al. 1998a, 1998b; Cebula, 1997; Dell'Anno and Solomon, 2008; Webb et al. 2013; Dell'Anno et al., 2007; Buehn and Schneider, 2012; Anderson, 2012) admitted that many factors affect the underground economy, including the tax burden and the size of the government. In fact, the quality of public institutions is another key factor for the development of the informal sector (Johnson et al., 1998a; Friedman et al., 2000; Choi and Thum, 2005; Dreher and Schneider, 2009; Dreher et al., 2009; Schneider, 2010; Buehn and Schneider, 2012; Teobaldelli, 2011; Teobaldelli and Schneider, 2012; Amendola and Dell'Anno, 2010; Losby et al., 2002, Schneider and Williams, 2013). The country's level of economic growth can have an important impact on the direction of causality, since richer economies may have less incentives or possibilities to go underground than less-developed ones (Dell'Anno et al., 2007). In addition, the higher self-employment is,

the more activities can be done in the shadow economy (Dell'Anno et al., 2007; Tedds, 2005; Hassan and Schneider, 2016; Schneider and Williams, 2013; Feld and Schneider, 2010).

Compared to previous studies, our article contributes to the related literature in two respects. First, to our knowledge none of the empirical studies used a dynamic modeling approach of simultaneous equations to study the two-way causal relationship between the shadow economy and the unemployment while taking into account the role of the institutional quality. Second, rethinking this type of relationship in our study attempts to provide fresh evidence of comparisons for a large number of 38 developing and 40 developed countries is a contribution to our analysis which represents a crucial concern because the importance of the shadow economy to the official economy varies across countries.

The remainder of this paper is developed as follows. Section 2 examined the literature review. Section 3 discusses the method used for the empirical analysis and presents the database. Sections 4 presents the empirical results and explains the causality. The last section concludes.

2. Literature review

Over the last decade, the recent interest in the relationship between the shadow economy (SE) and the level of unemployment has prompted a thorough assessment of the type of this relationship in various countries of the world. The existing literature showed that the unemployment rate, the reduction of the number of working hours, the tax burden, self employment, the quality of governance and economic growth can be major factors in the enlargement of the shadow economy. According to Bajada and Schneider (2018), the informal economy in the developed countries takes place in an illegal framework where this sector is classified as either a non-observed economy or a black market, whereas in the developing countries, this economy seems to be legitimate. In fact, the higher the tax burden, the greater the difference between the labor costs in the formal economy and the after-tax earnings from work, which increases the supply of labor in the informal sector (Johnson et al. 1998a, 1998b; Cebula, 1997, Dell'Anno and Solomon, 2008; Webb et al. 2013; Buehn and Schneider, 2012; Anderson, 2012). In addition, the increase of the additional costs that formal enterprises have to pay to recruit a worker induce people to work in the informal economy (Schneider and Enste, 2000; Thomas, 1992; Tanzi, 1999; Schneider, 2003, 2005; Dell'Anno, 2007; Dell'Anno et al., 2007; Buehn and Schneider, 2012). The tax burden proves to be one of the causes of an increase of the size of the informal sector (Torgler and Schneider, 2007).

However, Schneider and Neck (1993) found that the relationship between the shadow economy and the tax burden does not necessarily hold. Besides, several researchers such as Riebel (1983), De Gijbel (1984), Lemieux et al. (1994) and Enste (2003) suggested that the reduction of the working hours drives employees to devote some time to work in the informal sector. On the other hand, Enste (2003) showed that early retirement increases the number of working hours in the shadow eocnomy. Moreover, the higher the number of self-employed workers, the greater the activity in the underground economy (Feld and Schneider, 2010; Schneider and Williams, 2013). According to Bordignon and Zanardi (1997), a high self employment rate leads to a parallel economy increase insofar as these workers can collaborate with their customers to avoid indirect taxes. They found that it is easier for large firms to employ irregular workers because they have fewer internal and external audit control. Furthermore, the quality of governance represents a key factor for the development of the informal sector (Johanson et al., 1997; Friedman et al., 2000; Dreher and Schneider, 2009; Dreher et al., 2007, 2009; Schneider, 2010; Buehn and Schneider, 2012; Teobaldelli, 2011; Teobaldelli and Schneider, 2012; Amendola and Dell'Anno, 2010; Schneider, 2010; Buehn and Schneider, 2010; Schneider and Williams, 2013; Schneider, 2014). Incentives for work in the informal sector can result in increased labor costs in the shadow economy and therefore these costs can be transferred to employees (Losby et al. 2002; Dreher et al., 2009; Johnson et al. 1998 and Friedman et al. 2000; Teobaldelli and Schneider, 2012). In fact, a high level of corruption can increase the size of the informal economy because formal enterprises will be more taxed, which leads to more informality in the economy. According to (Johanson et al., 1997) corruption positively affects the shadow economy and negatively the official economy. In addition, Johnson et al., (1998) affirmed that corruption and government officials appear to be associated with larger unofficial activities, while a good state of law, which guarantees the respect of the rights of ownership and the respect of the contracts, increases the advantages of being formal. For their part, Buehn and Schneider (2009) found a positive relationship between corruption and the shadow economy. As for Dreher et al. (2008), they extended an explicit model of institutional quality and showed that corruption and the underground economy are substitutes, which means that the existence of the underground economy reduces the propensity of civil servants to demand lower payments. According to Djankov et al, (2002) entrepreneurs in the informal sector resort to public administration corruption to avoid administrative regulations. Several authors, such as (Loayza, 1996; Arimah, 2001; Zaman and Goschin, 2015; Borlea et al., 2017; Jerzmanowski, 2017; Wiseman 2017; Mandroshchenko et al., 2018) advanced several studies on the relationship of the shadow economy and economic

growth. On the other hand, Schneider and Klingmair (2004) established a comparative study between the developed and developing countries. They showed a procyclical relationship between the activity of the legitimate economy and the underground economy for the developed countries, but counter-cyclical for the developing economies. In addition, a recession period could lead to reduced shadow economic growth due to reduced growth in the formal economy. Thus, an increase of the growth rate raises the relative size of the shadow economy due to the increased demand for goods and services from enterprises of formal economy. As a result, there is a direct relationship between the size of the shadow economy and the growth of the formal economy. It is thus noted that Bacchetta et al. (2009) and La Porta and Shleifer (2014) showed that the underground economy has also a negative impact on economic growth because the informal economy reduces global competitiveness and decreases the working conditions due to unfair competition from the side of the companies that use illegal sales or working methods. This result seems to be consistent with those of Loayza (1999), Johnson et al. (1997) and Levenson and Maloney (1998) who showed that an increase of the size of the informal sector reduces a country's rate of economic growth. Furthermore, La Porta and Shleifer (2014) suggested that the informal sector is not very productive compared to the formal sector because the latter's products are of a much better quality than the former's.

Regarding our interest relationship between the shadow economy and the unemployment rate, the most important supporters for this approach are (Tanzi, 1999; Giles et Tedds, 2002; Dell'Anno et al. 2007; Feld and Schneider 2010; Tafenau et al., 2010; Anghelache et al., 2015) who reported different effects between these variables of interest. The nexus between the shadow economy and the unemployment rate remains one of the most important issues in the economic literature. The nature of this relationship is controversial (Tanzi, 1999; Giles and Tedds, 2002; Dell'Anno et al., 2007). The literature makes it possible to determine two expected signs of this relationship (positive or negative), because of unemployment which is negatively linked to the growth of the official economy (Okun's Law) and the shadow economy tends to increase in line with the growth of the official economy. Then, an increase of the unemployment rate involves a decrease in the shadow economy (Giles and Tedds, 2002). Following this theoretical ambiguity, several authors, such as (Boeri and Garibaldi, 2002; Dell'Anno and Solomon, 2007; Dobre et al., 2010; Mauleón and Sardà, 2017) empirically explored this relationship and admitted that generally there is a positive relationship between the shadow economy and unemployment. Based on the SVAR analysis in the USA,

Dell'Anno and Solomon (2007) showed that there is a positive short-term relationship between the unemployment rate and the informal economy. Similarly, Dobre et al., (2010) found the same results for USA data covering the period from 1980 to 2007 implying that the unemployment rate increases the shadow economy. This implies that an increase of the unemployment rate in the formal sector leads to an increase of the number of people working in the underground economy, which leads to an expansion of the size of the underground economy. In addition, Alexsandru et al., (2011) used Toda-Yamamoto approach for U.S.A. over the period 1980-2009 and found the existence of a long-run relationship between the variables and a unidirectional causation that runs from the unemployment rate to the shadow economy. As for the Italian regions, Boeri and Garibaldi (2002) showed a positive relationship between the unemployment rate and the informal economy. Using ARDL causality for Romania over the period 2000-2010, Davidescu (2013) showed the existence of a long-run unidirectional causality that runs from the unemployment rate to the shadow economy. A similar point was raised by Alexandru and Dobre (2013) who examined this relationship using Romanian data covering the first quarter of 2000 and the second quarter of 2010. Based on causality tests, these authors showed a unidirectional causality ranging from unemployment to the informal economy. This result was consistent with that of a study conducted by Alexandru (2014). For a comparative study of 162 countries, including developing, Eastern European, Central Asian, and high income OECD countries over 1999 to 2006/2007, Schneider et al., (2010) found that there is no evidence of a significant relationship between unemployment and the shadow economy for the State economy. There is no influence of the shadow economy on unemployment in the developing countries rather in transition and the OECD countries. These results can be explained as higher unemployment rates because of the more regulated and thus less flexible labor markets, which significantly increases the size and trend of underground economies in OECD countries; while in the less developed economies, the revenues of the underground economy guarantee the subsistence of families. The informal sector thus stands out as a source of food and maintenance for corruption in the developing countries. Besides, a comparative study of 32 developing and developed countries over the period 1980–2009 carried out by Saafi et al., (2015a) used parametric and non-parametric techniques and examined the dynamic linkage between unemployment and informal economy. In particular, they found evidence of bidirectional relationship in Finland and Sweden indicating that high unemployment rates lead to high levels of underground economy and *vice versa*. Therefore, unidirectional evidence ranging from unemployment to the economy in parallel has been found in the United States, Jamaica

and Venezuela, implying that a faster rate of unemployment favors a larger share of the underground economy in total GDP. As for the Tunisian case, Saafi et al., (2015b) employed two different methodologies (a linear causality approach of Toda– Yamamoto, 1995 and a non-linear causality method of Kyrtsou-Labys, 2006) during the period between 1980 and 2009. By using both of these tests, they found a unidirectional causality ranging from unemployment to the informal economy, there is no "reverse causation" from the shadow economy to the unemployment rate. Generally, there is a significant gap between few theoretical studies and many existing empirical studies. Moreover, the conclusions of the two axes are not entirely convergent.

3. Econometric modeling and data

3.1. Description of data and presentation of variables

In this study, we have employed a panel data of 78 countries covering the 2000- 2015 period (see the appendix for the country list). The definition of the variables and their sources are presented in table 1. Our main variables of interest are the unemployment rate and the shadow economy. In addition, three measures of quality of governance, such as political stability, Corruption index and government effectiveness, were used. On the other hand, we employed control variables, such as inflation, GDP, self employment, tax burden, openness, size of government, gross fixed capital formation.

Looking at the descriptive statistics of the variables summarized in table 2, we notice that the highest average value and standard deviation of the unemployment rate and the Shadow Economy are recorded for developing than those developed countries. It is also noted that the developed countries are more volatile in terms of unemployment rate, which has a coefficient of variation of 76.66, which is the highest compared to that of the developing ones. Moreover, the shadow economy in the developing countries (33) is much higher than that of the developed ones (17.32).

This result corroborates that of (Putniņš and Sauka, 2015 and Medina and Schneider, 2018) who investigated the determination of the shadow economy. Their findings showed that the shadow economy maintains a lower average below 20% while in the developing countries, this averages higher as it exceeds 36%.

Table 1: Definition and source of variables

Variables	Definition	Sources
Unemployment rate (% of the labor force)	The unemployed persons aged 15–64.	WDI (2016)
Shadow economy (% of GDP)	Informality economy which means those economic activities and income earned that circumvent government regulation, taxation or observation.	Medina and Schneider (2018)
Inflation (GDP deflator, annual %)	The change of the prices of a basket of goods and services that are generally purchased by specific groups of households.	WDI (2016)
Self-employment (% of total employment)	Workers who, working on their own account or with one or a few partners or in cooperative, hold the type of jobs defined as a "self-employment jobs	WDI (2016)
Openness (**%** of GDP)	Corresponds to trade (in percentage of GDP). Trade is the sum of exports and imports of goods and services, measured as a share of gross domestic product (negative sign expected).	WDI (2016)
GDP per capita (current US$)	GDP per capita is gross domestic product divided by midyear population. Data are in current US dollars.	WDI (2016)
GFCF (% of GDP)	the net increase in physical assets (investment minus disposals) within the measurement period.	WDI (2016)
Tax burden (% of GDP)	A measure of the tax burden imposed by government. It includes direct taxes, in terms of the top marginal tax rates on individual and corporate incomes, and overall taxes, including all forms of direct and indirect taxation at all levels of government, as a percentage of GDP.	Heritage Foundation database
Size of government (% of GDP)	General government final consumption expenditures (in percentage of GDP, which includes all government current expenditures for purchases of goods and services; positive sign expected)	Heritage Foundation database
Political Stability Index	Perceptions of the likelihood of political instability or politically motivated violence.	WGI (2016)
Corruption Index	Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	WGI (2016)
Governance Effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of government's commitment to such policies.	WGI (2016)

In addition, the average GDP per capita (10.27), the tax burden (64.60) and openness (104.39) recorded the highest values for the developed countries followed by the developing ones, while the highest average of other variables such as, inflation, self-employment, size of the government and the GFCF are reported in the developing countries compared to the developed ones. Finally, the three measures of governance quality indicate that the value ranges from approximately -2.5 (poor governance) to 2.5 (good governance). On the other hand, the average of corruption, political stability index and governance effectiveness is equal, to (1.17), (0.75) and (1.128), respectively, for the developed countries and (-0.56), (-0.63) and (-0.38) for the developing ones. Table 3 shows the correlation matrix. Then, the relationship between corruption, self employment, size of the government and the tax burden with the shadow economy is positive, while the one between the governance effectiveness,

Table 2: Descriptive Statistics

Panel	Descriptive Statistics	UNEM	SE	GDP	INF	SELF EMP	SIZE GOV	TAX BURDEN	OPENESS	GFCF	CORRU-PTION	POLITICAL STABILITY	GOV EFFE
Developed	Mean	6.447	17.32	10.271	3.324	17.502	45.081	64.601	104.396	22.789	1.177	0.755	1.283
	Std.dev	4.942	7.270	0.4811	5.477	8.309	20.687	14.116	73.1179	4.033	0.835	0.600	0.614
	CV	76.66	41.975	4.684	164.771	47.475	45.889	21.851	70.039	17.697	70.943	79.470	47.857
Developing	Mean	8.862	33.002	8.6568	12.747	52.328	75.813	35.226	74.424	24.111	-0.5635	-0.635	-0.3862
	Std.dev	5.2948	10.047	0.830	108.30	18.630	10.694	13.857	35.226	8.591	0.487	0.7099	0.52988
	CV	59.75	30.444	9.588	849.612	35.602	14.106	39.337	47.332	35.631	-86.424	-111.795	-137.204
All sample countries	Mean	8.162	24.956	9.485	7.911	34.468	69.993	60.4973	89.794	23.429	0.329	0.077	0.469
	Std.dev	5.123	11.733	1.0519	75.781	22.529	13.774	23.895	59.734	6.6736	1.109	0.955	1.013
	CV	62.766	47.015	11.090	957.919	65.362	19.679	39.498	66.523	28.484	337.082	1240.260	215.991

Notes: Std dev. and CV indicate standard deviation and coefficients of variation, respectively.

Table 3: Correlation of variables.

Variables	UNEM	SE	GDP	INF	SELF EMP	SIZE GOV	TAX BURDEN	OPENESS	GFCF	CORRU-PTION	POLITICAL STABILITY	GOV EFFE
UNEM	1											
SE	-0.090	1										
GDP	0.122	-0.695	1									
INF	-0.002	0.083	-0.123	1								
SELF EMP	-0.204	0.654	-0.854	0.060	1							
SIZE GOV	0.036	0.307	-0.273	-0.028	0.259	1						
TAX BURDEN	-0.211	0.545	-0.624	0.050	0.656	0.581	1					
OPENESS	-0.073	-0.213	0.319	-0.037	-0.295	0.089	-0.0876	1				
GFCF	-0.170	-0.132	-0.080	-0.043	0.190	0.084	0.1677	0.0274	1			
CORRUPTION	-0.052	0.698	0.773	-0.078	-0.729	-0.448	-0.6075	0.2961	-0.0246	1		
POLITICAL STABILITY	-0.057	-0.586	0.637	-0.069	-0.624	-0.342	-0.5513	0.3750	0.0033	0.7768	1	
GOV EFFE	-0.047	-0.724	0.827	-0.095	-0.778	-0.432	-0.6243	0.3288	-0.0075	0.9435	0.7843	1

political stability, GDP is negative. On the other hand, the unemployment rate is negatively correlated with that of inflation, openness and gross fixed capital formation.

3.2. Econometric modeling

We estimate a dynamic panel data models within a simultaneous-equation framework implemented via the General Method of Moments (GMM) system estimator which first proposed by Arrelano and Bond (1991) and further developed by Arellano and Bover (1995) and Blundell and Bond (1998), jointly with the one-period-lagged levels of the dependent variables (*i.e.* Unemployment, Shadow economy). Therefore, our proposed models should look as follows:

$$U_{it} = \alpha U_{it-1} + \gamma SE_{it} + \varphi X_{it} + \mu_{it} \quad (1)$$

$$SE_{it} = \beta SE_{it-1} + \gamma' U_{it} + \delta X_{it} + \varepsilon_{it} \quad (2)$$

Where α and β are the coefficient of the lagged dependant variables the unemployment and the shadow economy respectively. γ and γ' are the coefficients of interest variables. φ indicates the control variables such as, the inflation rate, the openness and the GFCF which are determinants of the unemployment rate (Buehn et al., 2009; Feld and Schneider 2010; Schneider et al. 2010; Pattanaik and Nayak 2014; Williams and Schneider, 2016; Hassan and Schneider, 2016) while δ indicates the control variables such as, the size of government, self-employment, GDP, tax burden, corruption, political stability and governance effectiveness.

The application of the GMM consists in using a set of instrumental variables to solve the problem of endogeneity linked to the regressors. Besides, since the lagged dependent variables (U_{it-1}, SE_{it-1}) are correlated with the error term, the use of the panel of ordinary least squares (OLS) estimator (with fixed and random effects) avoids the estimation bias which can be derived from this estimate. Thus, to solve this problem, the GMM method for dynamic panels provides solutions for simultaneity bias problems of inverse causality and omitted variables. We use the xtabond2 command (Roodman, 2009a) to run System GMM estimation in Stata.

We used three tests for empirical models. The test of Blundell and Bond (1998) is first applied to analyze the existence of second-order autocorrelation in the first differential errors. The Sargan test which is considered as an orthogonality test between regressors and instruments in the estimation of GMM. The instruments' validity will be tested also through the Hansen test. The "Durbin-Wu-Hausman test" aims at controlling endogeneity.

4. Main results and discussions

Table 4: Results of dynamic simultaneous-equation

Independent variables	Developed countries		Developing countries	
	Model 1	Model 2	Model 1	Model 2
UNEMP	-	0.109** (0.017)	-	0.231*** (0.005)
$(UNEMP)_{t-1}$	0.851*** (0.010)	-	0.568*** (0.007)	-
SE	-0.041* (0.061)	-	0.004 (0.101)	-
$(SE)_{t-1}$	-	0.684*** 0.026	-	0.793*** (0.025)
Inflation	-0.054*** (0.003)		-0.021*** (0.001)	
Openness	-0.002*** (0.001)		-0.003*** (0.0007)	
GFCF	-0.423 (0.012)		-0.220 (0.062)	
Corruption index		0.223** (0.120)		0.282*** (0.105)
GDP		-0.534** (0.264)		-2.575 (0.696)
Self-employed		0.171*** (0.010)		0.149** (0.064)
Size of government		0.011** (0.002)		-0.002 (0.014)
Tax burden		0.099** (0.004)		0.116** (0.008)
Governance effectiveness		-0.772*** (0.224)		-0.256** (0.226)
Political stability		-1.676 *** (0.355)		-0.113 (0.149)
Observations	560	559	523	517
Instruments	50	83	65	113
Constant	5.234*** (0.638)	9.957*** (3.046)	1.687*** (0.173)	34.682*** (10.365)
AR2 test (p-value)	0.983	0.988	0.368	0.295
Sargan test (p-value)	0.747	0.776	0.996	0.989
DWH test (p-value)	0.0001	0.0001	0.0002	0.0002

Notes: Standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 % levels, respectively. Model 1 and Model 2, respectively refer to unemployment and shadow economy, the two dependent variables.

The two-way linkages between shadow economy and unemployment are summarized in table 4 for the three panels (developed, developing and all sample countries). The main idea behind a dynamic simultaneous-equation is to examine the relationships among variables of unemployment and shadow economy. Based on our model, the results of these different tests show that the AR (2) (Arellano and Bond, 1991) tests have no evidence of autocorrelation at conventional

significance levels. The results of the Durbin-Wu-Hausman test indicate that the effects of endogenous regressors on the estimates are significant and that the techniques of the instrumental variables seem to be imposed. Moreover, the Sargan tests shows that the model is valid and do not suffer from over-identifying problem. In addition, Hansen's J statistics on overidentification testing restrictions show the non-significance of this test so the null hypothesis of overidentified restrictions can not be rejected which indicate that the instruments are valid in the respective estimation.

Our econometric estimations are presented for 38 developing and 40 developed countries. For every sample, two estimations are shown where models 1 and 2, refer to the unemployment and shadow economy, the two dependent variables, respectively. The estimated coefficients of the lagged dependant variables have a statically positive impact on the dependant variables. In the developed countries, the results show a bidirectional relationship between the shadow economy and the unemployment rate. Model 1 shows that the shadow economy negatively and significantly affects the unemployment rate at 10% level. In fact, the underground economy, which functions as a kind of "economic buffer" and "flexibility reserve" (Cassel, 1993), compensates for the economic disturbances resulting from the failure of a government. Hence, more flexible prices and wages instead of those regulated in the formal economy lead to the reduction of quantitative adjustments, such as the unemployment rate. Model 2 shows that the unemployment rate may weaken slightly the informal economy at 10% level. Moreover, a 1% increase of the unemployment rate leads to a 0.10% increase of the shadow economy. This means that due to the more regulated and thus less flexible labor markets, the unemployment rate is increasing, which leads to an increase of the size of the underground economy (Schneider, 2010). In fact, a higher unemployment rate pushes individuals to operate in the shadow economy to find jobs (Dell'Anno et al., 2007 and Schneider et al. 2010). According to Feld and Schneider (2010) and Schneider and Williams (2013), an increase of the number of the unemployed increases the number of people who work in the black economy because they have more time. This result corroborates that of (Boeri and Garibaldi, 2002; Dell'Anno and Solomon, 2007; Dobre et al., 2010; Alexandru 2014; Alexandru et al., 2010; Alexandru and Dobre, 2013; Mauleón and Sardà, 2017) and contradicts that of (Giles and Tedds, 2002). Moreover, the country's level of economic growth can have an important impact on the direction of causality, since richer economies may have less incentives or possibilities to go underground than less developed ones (Dell'Anno et al., 2007). As shown in table 4, the magnitude of the GDP per capita may account for this divergence (0.53%) for the developed countries and 2.57% for the developing ones.

In the developing countries, there is a unidirectional relationship between the unemployment and the shadow economy. From model 1, the relationship between the unemployment rate and the shadow economy is positive but not significant. In fact, the growth of the informal economy leads to the reduction of jobs and wages as a result of competition in the formal economy, which in turn, leads to an increase of the official unemployment rate. Model 2 shows that the unemployment is a significant determinant of the shadow economy in the developing countries. The unemployment rate can strongly induce the increase of the shadow economy at 1% level. This means that an increase of 1% of the unemployment rate leads to 0.23% increase of the shadow economy. In these countries, the income earned in the shadow economy guarantees the subsistence of families. In addition, a faster rate of unemployment promotes a higher share of the underground economy in the total GDP. Our empirical results are consistent with those of (Shneider, 2010; Davidscu, 2013; Saafi et al., 2015a, 2015b). On the other hand, when the global economy is in a constant recession and unemployment increases continuously, unemployment affects the development of the underground economy. According to Hassan and Schneider (2016), the number of jobs available in both the informal and the formal economies is limited due to the continued contraction of the entire economy and the high unemployment rate. In fact, the unemployment rate in the developing countries has a significant effect on the size of the shadow economy.

Regarding the quality of governance, the coefficient of control of corruption is statistically positive and significant in both the developed and developing countries at the levels of 5% and 1%, respectively. This implies that the increase of corruption increases the unemployment, more significantly in the developing countries than in the developed ones. This result can be explained by the weak governance of the developing countries. Comparing high-income and low-income countries, Choi and Thum (2005) and Dreher et al. (2008) suggested that entrepreneurs are not required to pay the bribes claimed by public servants, because they could always sue corrupt officials in court, so they can choose to pay a bribe or work in parallel in the high income countries while in the low income ones, entrepreneurs who engage in the underground economy can expect to avoid prison when their illegal activity is detected. In addition, according to La Porta et al. (2002), a strict regulation gives rise to great corruption and then, reduction of competition. This same conclusion was obtained in the study by Djankov et al. (2002). According to Schneider et al. (2008), the informal economy has been reduced in high-income countries but increased in low-income ones. This implies that more revenue for civil servants can reduce the possibilities of welding.

Regarding, the results of the estimated coefficients of political stability and government effectiveness are comparable. It seems that regulation is a much more important determinant in the developed countries than in the developing ones. In the developed countries, political stability and government effectiveness are negative and statistically significant on the shadow economy, while in the developing ones, they are not. This means that the quality of governance presents a significant determinant of the shadow economy in the developing countries compared to the developed ones.

In general, the quality of institutions significantly affects people's motivations to participate in the shadow economy (Schneider, 2010; Razmi et al., 2013 and Hassan and Schneider, 2016). In the developing countries, the shadow economy is positively and significantly affected by the tax burden and self employment at 5% level, since a 1% increase of the tax burden and self employment increases the size of the shadow economy by around 0.01% and 0.14%, respectively. This implies that the overall tax burden affects labor-leisure choices and may stimulate labor supply in the shadow economy (Schneider, 2003, 2005), Dell'Anno (2007), Dell'Anno et al., (2007) and Buehn and Schneider (2012). According to Enste (2015), high taxes and social security contributions and heavy regulation are the main sources of the shadow economy. This means that the higher self-employment is, the more activities can be carried out in the shadow economy (Dell'Anno et al., 2007; Tedds, 2005; Hassan and Schneider, 2016; Schneider and Williams, 2013; Feld and Schneider, 2010). Furthermore, there is a statistically negative and significant relationship between size of the government and shadow economy in the developing countries than in the developed ones. It should be noted that the increase of the size of the government reduces the shadow economic growth if the quality of institutions is good and reflects the government's good allocation of resources. Moreover, inflation and trade openness have a negative and statistically significant effect at 1% level on the unemployment rate while the gross fixed capital formation has insignificant effect on unemployment rate. Finally, the coefficient of the GDP is negative and significant for the developed countries compared to the developing ones. The GDP per capita does not have a significant effect on the size of the shadow economy of the developing countries, while it has a high negative impact in the developed ones, which implies that a stronger economic growth reduces the size of the underground economy. This implies that the incentive to work in the informal economy is higher when economic growth is strong. Our results seem to be consistent with those of (Loayza, 1996; Johnson et al., 1997; Levenson and Maloney, 1999; Bacchetta et al., 2009; La Porta and Shleifer, 2014).

5. Robustness check

In order to better understand the nexus between the shadow economy and unemployment, we also examined whether the quality of institutions since corruption and political stability are important possible factors that can explain the divergent causality results (see *inter-alia*, Johnson et al., 1997; Friedman et al., 2000; Bovi and Dell'Anno, 2010; D'Hernoncourt and Méon, 2008; Mara, 2011).

Table 5 presents the baseline model with the two-interaction term (the shadow economy× corruption), (shadow economy × political stability). For better comparability, the structure in table 5 is the same as in table 4. The insertion of the two interactions provides a positive and significant coefficient of the interaction term in the developing countries than in the the developed ones. For the developing countries, the effect of the unemployment rate on the underground economy remains negative and significant with a greater magnitude of 0.36%, which means that the positive effect of the informal economy on the unemployment rate increases with corruption. This also implies that the shadow economy and corruption are complements (Choi and Thum, 2005 and Dreher et al., 2008) for the case of the developing countries while the negative effect of both informal economy and the unemployment rate decreases with political stability. As a consequence, a wider underground economy reduces political stability and encourages the unemployment rate.

However, in the developed countries, the coefficient result of the unemployment rate with the shadow economy has become lower indicating that a 1% increase of the unemployment rate entails a 0.09% increase of the underground economy to the level of 10%. In addition, the two terms of the interactions are statistically insignificant, which implies that an unemployment rate that leads to the emergence of the shadow economy does not have an indirect impact via corruption or political stability. It is also noted that the results remain unchanged for most control variables for the developed and developing countries. Our result confirm that of Dreher and Schneider (2009) who found that corruption and the informal sector are complementary in the developing countries, but substitutable in the developed ones. In fact, the relationship of complementarity or substitutability depends on the level of development of the countries. However, in developing countries, informal activities take place through the payment of bribes. Thanks to the possibility of making these payments, informal entrepreneurs in the developing countries are able to circumvent the regulations. On the other hand, the substitutability between the informal sector and corruption in the developed

countries can be explained by the fact that, in the face of some constraints, such as the increase of the unemployment rate and the economic crises, the informal sector, or at least informal employment, appears as an alternative for workers. In the case of unemployment, the only possibility for workers is to provide services to employers in the informal sector: the black market for employment; market on which employers do not pay social charges.

Table 5: Model with interaction

Independent variables	Developed countries		Developing countries	
	Model 1	Model 2	Model 1	Model 2
UNEMP	-	0.090* (0.012)	-	0.361*** (0.006)
$(UNEMP)_{t-1}$	0.545*** (0.006)	-	0.873*** (0.005)	-
SE	-0.306** (0.023)	-	0.013 (0.102)	-
$(SE)_{t-1}$	-	0.545*** (0.039)	-	0.793*** (0.025)
Inflation	-0.065*** (0.002)		-0.013*** (0.0009)	
Openness	-0.001** (0.002)		-0.001*** (0.0006)	
GFCF	0.392 (0.014)		-0.010*** (0.0015)	
GDP		-0.803** (0.198)		-2.671 (0.682)
Self-employed		0.266*** (0.021)		0.192** (0.072)
Size of government		0.014 (0.003)		0.0007 (0.025)
Tax burden		0.040** (0.010)		0.014** (0.017)
Governance effectiveness		-0.817** (0.366)		-0.222** (0.426)
Shadow economy* Corruption		0.018 (0.001)		0.008*** (0.0006)
Shadow economy* Political stability		-0.050*** (0.007)		-0.042*** (0.006)
Observations	560	559	523	517
Instruments	65	113	65	113
Constant	7.661*** (0.872)	12.971*** (2.836)	0.726*** (0.055)	38.144*** (10.148)
AR2 test (p-value)	0.934	0.994	0.378	0.374
Sargan test (p-value)	0.993	0.969	0.998	0.985
DWH test (p-value)	0.00012	0.0001	0.0000	0.0000

Notes: Standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 % levels, respectively. Model 1 and Model 2, respectively refer to unemployment and shadow economy, the two dependent variables.

In sum, both in the developing and developed countries, an increase of the unemployment rate can lead to a sharp rise of the shadow economy if institutional quality is high enough, but this negative effect of the underground economy can be mitigated if institutional quality is reduced. In particular, a bureaucracy with highly corrupt government officials seems to be associated with larger unofficial activities, while a good rule of law by securing property rights and contract enforceability increases the benefits of being formal. In addition, a strong political stability can combat the shadow economy that a low level cannot do it.

Conclusion and policy recommendations

This paper empirically examines the relationship between the shadow economy and the unemployment rate in the developing and developed countries using a dynamic simultaneous-equation for annual data for the period 2000–2015. In fact, the increase of the unemployment rate favors the increase of the shadow economy in the developed and developing countries, and reduces the shadow economy mainly in the developed countries. This conclusion is quite solid because it resists a battery of sensitivity like the inclusion of terms of interactions between the variables of interest and the institutional quality.

In fact, in the developing countries, the terms of interaction between the underground economy and corruption has a positive and significant influence on the increase of the unemployment rate, implying that a high level of corruption increases the effect of the underground economy on the unemployment rate. However, in the developed countries, they do not have a statistically significant impact. These results imply that if the level of corruption is too high, an increase of the unemployment rate can increase the size of the underground economy. However, a good quality of institutions, where control mechanisms and the fight against corruption are well established may weaken the effect of the unemployment rate on the informal economy. In addition, the size of the shadow economy negatively and significantly affects the political stability and government effectiveness while it positively and significantly affects the tax burden in the case of the developed countries, while in the developing countries, only the government effectiveness negatively and significantly affects the shadow economy since the political stability cannot do it.

In the light of our findings, we emphasize some policy implications enabling the developing and developed economies to combat unemployment through a proper integration of the informal sector. First, the unemployment rate is associated with a larger size of the informal economy in the developing countries rather in the developed ones, the government's policies

should fight corruption and thus minimize the positive impact that the terms of interaction between the underground economy and corruption. In fact, governments should boost efficiency in the administration and combat corruption. Furthermore, governance effectiveness can reduce the size of the underground economy, while political stability cannot do it. Governments should encourage firms to move out of the shadow economy by improving public institutions and therefore can create an environment conducive to the exercise of formal activities in order to attract informal ones. Policymakers should strengthen more democracy through a greater popular participation in the government decision-making process and avoiding corruption, which can minimize the informal economy. Secondly, the unemployment rate is associated with a smaller size of informal economy in the developed countries to the extent that the role of corruption and the underground economy act as substitutes in the sense that the existence of the underground economy reduces the propensity of public servants to demand lower payments. In addition, a strong political stability and government efficiency can combat an underground economy that a low level can not do. Both in the developing and developed countries, an increase of the unemployment rate can lead to a sharp rise of the shadow economy if institutional quality is high enough, but this negative effect of the underground economy can be mitigated if institutional quality is reduced.

The developed and developing countries have proved the relation between the unemployment rate and the underground economy. In fact, their attempt has not been translated into institutional quality reinforcement, which reflects the fact that the unemployment rate affects the shadow economy through various channels of transmission which will be essential to study in future research.

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Appendix: Countries included in the analysis

Developed countries		Developing countries	
Australia	New Zealand	India	Indonesia
Austria	Norway	Albania	Jordan
Belgium	Poland	Algeria	Honduras
Canada	Portugal	Angola	Indonesia
Chile	Slovenia	Argentina	Jamaica
Cyprus	Korea republic	Bangladesh	Lebanon
Czech Republic	Spain	Benin	Libya
Denmark	Sweden	Bhutan	Malaysia
Estonia	Singapore	Brazil	Morocco
Finland	Switzerland	Burkina Faso	Peru
France	Turkey	Cameroon	Paraguay
Germany	United Kingdom	Chad	Philippines
Greece	United States	China	Senegal
Iceland	Bulgaria	Colombia	Sri Lanka
Israel	Croatia	Congo, Dem. Rep	Thailand
Italy	Latvia	Ecuador	Tunisia
Japan	Lithuania	Egypt, Arab Rep.	Vietnam
Luxembourg	Malta	El Salvador	Yemen, Rep.
Netherlands	Romania	Guatemala	Venezuela
Slovakia		Iran, Islamic Rep.	

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