Internet Usage and the Shadow Economy: Evidence from Panel Data

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Abstract:

The enormous spread of the internet in the last 20 years has been having various economic consequences. In this paper I ask whether the spread of the internet aided or abetted the shadow economy. To this end, using a panel data of 152 countries over 9 years from 1999 to 2007, I examine the empirical relationship between the degree of internet usage and the size of the shadow economy. Panel and cross-section estimation results indicate that the association between internet usage and shadow economy size strongly interacts with GDP per-capita. I also suggest and then empirically test an economic mechanism to account for this observation.

Keywords: shadow economy; internet usage; panel-data

JEL Classification Numbers: E 26, O17, O30.

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1 Introduction

The enormous spread of the internet in the last 20 years has been having various economic consequences. These effects on the economy are spanning in a wide range of areas from technological productivity to foreign direct investment or from inflation to political economy issues. To name a few, Sussman (2000) investigated the effect of the internet spread on press freedom. Freund and Weinhold (2000, 2004) examined the relationship between internet usage and international trade and found that '*the internet stimulates trade.*" Similarly, Choi (2003, 2010) and Choi and Yi (2005, 2009) looked at the effects of internet usage on foreign direct investment, service trade, inflation and economic growth in various panels of countries and found evidence towards the existence of significant economic effects of the internet. In another paper Naude and Saayman (2005) showed internet usage as one of the main determinants of tourist arrivals. Finally, in a more recent paper Goel, Nelson and Naretta (2012) study the effect of the internet on corruption and their empirical analysis shows that with its news-disseminating capacity (See Sussman, 2000 and Katz and Rice, 2002 for this) the internet increases corruption awareness and therefore deters corruption.

From a broader perspective, the spread of internet usage is part of the Information and Communication Technologies (ICT) revolution. The development in ICT has a substantial positive impact on various economic outcomes. (Noh and Yoo, 2008). Productivity increase (Oliner and Sichel, 2000, 2003; Varian et al. 2002; and Dewan and Riggins, 2005), inflation reduction (Choi and Yi, 2005), a higher volume of trade (Freund and Weinhold 2000, 2004), a higher economic growth (Roller and Waverman, 2001 and Choi and Yi, 2009) are among these positive outcomes. In this regard, Indjikian and Siegel (2005) provide an excellent survey on the economic effects of the spread of ICT in developing economies.

Notwithstanding the increasing focus on the economic aspects of internet usage, the

impact of the internet on various economic, political and social variables is still an under-investigated field of research.

Yet another largely under-explored economic phenomenon is the prevalence of the shadow economy; sometimes also titled informal, underground, black or hidden economy; across the national economies in the world, which definitely poses serious economic, social and political challenges. Partially thanks to the recently developed and widely accepted methods (See Schneider and Enste, 2000; Schneider, 2005, 2007 and Schneider, Buehn and Montenegro, 2010 or Elgin and Oztunali, 2012 for different methodologies) to estimate its size, there is an increasing attention on the economic causes and consequences of informality. As the size of the shadow economy is significantly affected by variations in economic, political and social variables, the relationship between internet usage and the shadow economy is very much worth to study.

Aiming to combine these two streams of literature on internet usage and informality, in this paper I ask whether the spread of the internet aided or abetted the shadow economy. To this end, using a panel data of 152 countries over the 1999-2007 period, I examine the empirical relationship between the degree of internet usage and the size of the shadow economy. Panel estimation results indicate that the association between internet usage and shadow economy size strongly interacts with GDP per-capita. Specifically, internet usage and informal sector size are negatively correlated with each other; however as GDP per-capita increases this negative correlation is reduced. Moreover, at higher GDP per-capita levels, it even can become positive. As I will show in the following sections of the paper, this result is robust to different econometric specifications, inclusion of various control variables, use of different internet usage statistics and focusing on different regional subsets of the data. Once having established such an association between internet usage and informal sector size, I also suggest and then empirically test an economic mechanism to account for this observation. The theoretical framework I build argues that a varying degree of internet usage potentially creates two effects on informal sector size

through two distinct causes of informality. One of these two effects work through changing productivity and another one through taxes. Accordingly, one should expect that Increasing (decreasing) internet usage should be associated with increasing (decreasing) productivity and increasing (decreasing) taxes. As productivity is negatively and taxes are positively correlated with informal sector size, internet usage has the potential to create two opposing effects on informality. Moreover, the empirical analysis I perform also shows that the effect of internet usage on informality through productivity is more pronounced in countries with lower GDP per-capita whereas the effect through taxes is stronger in richer countries. This mechanism establishes an account for why the association between internet usage and informal sector size interacts with GDP per-capita.

The rest of the paper is organized as follows. In the next section, I construct a theoretical framework to hypothesize how the relationship between internet usage and shadow economy manifest itself in the data. Then, in the third section I present the data along with empirical results. Finally, in the fourth section I provide some concluding remarks and discussion.

2 Theoretical Background

One purpose of this section is to provide a theoretical hypothesis to account for the possible association between internet usage and the shadow economy size. Provided that there exists an association, I also want to be able to form a theoretical hypothesis behind this potential relationship between these two variables.

As documented above in the introduction, the most frequent finding in the empirical literature on the economic effects of internet is that the spread internet usage is generally associated with positive economic outcomes such as more trade, higher levels of growth, lower inflation etc. With this reasoning, one can immediately tend to expect a direct negative correlation between internet usage and the size of the shadow economy. However,

as also suggested by Indjikian and Siegel (2005) and Noh and Yoo (2008) the effects of internet is potentially different in developing and developed economies. Therefore, a robust empirical analysis should definitely check the existence of this potential difference. In empirical terms, this should be done using an interaction variable of internet usage with GDP per-capita.

Moreover, taking this interaction aside, I hypothesize that the varying degree of internet usage (possibly interacting with GDP per-capita) carries the potential to create two distinct effects on shadow economy size potentially working in opposing directions. These are the productivity effect and and the tax-evasion effect of internet diffusion.

2.1 Productivity Effect

Diffusion of internet usage across the public is part of the ICT revolution and therefore is definitely a technological advancement. As suggested by Oliner and Sichel (2000, 2003), Varian et al. (2002), and Dewan and Riggins (2005) ICT has a significantly positive effect on productivity in industrial or aggregate level. Moreover, productivity is also one of the key factors affecting shadow economy size. As an increase (reduction) in productivity does not affect formal and informal sectors symmetrically (See Roca, Moreno and Sanchez (2001) and Elgin (2012) for this point.) I would expect that this would decrease (increase) informal sector size. Moreover, again, I would expect the magnitude of the productivity effect of internet diffusion to be potentially different in developing and developed economies because of the existence of the diminishing marginal returns to productivity. Therefore, I would expect that the productivity effect is less pronounced in countries with higher GDP per-capita.

2.2 Tax-Evasion Effect:

Another possible effect of internet diffusion on shadow economy size might run through tax evasion. As suggested by the literature, increasing internet usage enhances online transactions which makes tax-evasion much easier for firms and households. (See Goolsbee, 2000, 2001, Bruce, Fox and Murray, 2003 among many others.) As electronic commerce is more prevalent in richer countries, I would also expect this effect to be stronger in countries with higher GDP per-capita. Moreover, an increasing degree of tax evasion would also increase the statutory tax burden on the formal sector, thereby creating another factor for further informality.

One notice I should make at this point is that the suggested effects of internet usage can easily be generalized. Namely, the productivity effect of internet usage which is reducing the shadow economy size can be interpreted to be of one push-effects of internet diffusion, which pushes informal firms and households towards the formal economy. For example, corruption is generally seen as one of the main determinants of informality and as suggested by Goel, Nelson and Naretta (2012) internet diffusion is associated with less corruption. Similarly, the tax-evasion effect can be generalized and be interpreted to be one of pull-effects of internet usage. However, as I will present in the next section, among various possible pull and push effects, the existence of the ones (productivity and tax-evasion effects) that I have hypothesized in this paper are supported by an empirical analysis.

3 Empirical Analysis

In this section, I conduct panel regressions to examine the association between informal sector size and internet usage.

3.1 Data

The regressions in this section will use informal sector size as % of GDP as the dependent variable. These I obtain from the estimates of Schneider, Buehn and Montenegro (2010).

Table 1: Complete Dataset Summary Statistics

	Mean	Std. Deviation	Minimum	Maximum
Internet Users Per-Capita	15.73	20.68	0.00	88.89
Internet (Wired) Subscriptions per-capita	7.51	10.69	58.89	
Broadband Subscriptions per-capita	3.14	6.60	0.00	44.65
% of individuals using ICTs	58.87	23.62	6.60	93.40
Informal Sector Size (in %)	33.14	12.98	8.10	68.30
GDP per-capita (thousand USD)	7.13	10.40	0.08	56.62
Openness (% GDP)	89.55	52.53	4.83	453.44
Productivity	0.49	0.31	0.05	1.85
Government exp. (% GDP)	15.21	5.68	2.29	42.95
Urbanization (%)	55.84	23.52	8.34	100.00
Law and Order Index	3.88	1.35	0.50	6.00
Democracy Index	3.99	1.68	0.00	6.00
Bureaucratic Quality Index	2.22	1.10	0.00	4.00
Censorship	0.25	0.53	0.00	1.00
Tax Burden (% GDP)	17.16	7.07	0.82	57.49

For the key independent variable of the first pass of the empirical analysis, namely internet usage, I first use internet users (per 100 people) from the World Development Indicators. (WDI) However, to check the robustness of my results, I also use three other variables to proxy for internet diffusion. These are Internet (Wired) Subscriptions per-capita, Broadband Subscriptions per-capita and finally % of individuals using ICTs in the last 12 months. These three variables are obtained from the International Telecommunication Union's website. Among these, all series are available in a panel data format from 2000 to 2007 except the last one which is only available for a cross-section of countries for year 2007.

Moreover, I use various control variables in my regressions. These are real GDP per-capita, openness (defined as the ratio of the sum of exports and imports to GDP), government expenditure (as % of GDP), urbanization (defined as the percentage of urban population), productivity.[1] and three institutional indices, namely law and order, democratic accountability, and bureaucratic quality indices. I obtained the openness, government expenditure, and GDP per-capita series from Penn World Tables, urbanization from WDI and the institutional quality indices from International Country Risk Guide of Political Risk Services.[2] I also control for the tax burden (defined as the ratio of the total tax revenue to formal GDP[3]) which I obtain from the Government Finance Statistics of the IMF. Finally, I also control for the existence of censorship on internet as it might be crucial to determine the effects of internet. This is represented by a dummy variable titled Censorship. The source is the Reporters without Borders website.[4]

Ceteris paribus, I expect that informal sector size is positively correlated with taxes and negatively correlated with urbanization, productivity, openness, and institutional quality indices.

Table 1 reports the summary statistics of all the data I use in my empirical analysis. The dataset (except the % of individuals using ICTs) is an unbalanced panel data set with 152 countries over 9 years from 1999 to 2007.

[1]As a measure of productivity, I use the total factor productivity (TFP) series I construct assuming a Cobb-Douglas production function of the form $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$ where Y_t stands for GDP, A_t, TFP, K_t for capital and L_t for labor. Due to space constraints I do not go into the details of the construction of the TFP series, however these are available upon request from the author.

[2]See http://www.prsgroup.com/ICRG.aspx for details.

[3]Notice that, this definition of the tax burden allows us to interpret this as a measure of statutory taxes. See Elgin (2010) for more details on the construction of this.

[4]The dummy is constructed so that it assigns 1 to countries under the categories of "Enemies of Internet" and "Countries under Surveillance" and 0 otherwise.

3.2 Panel Data Analysis

When panel data is available, I estimate the following equation using a fixed-effects estimator in a panel-data setting:

$$IS_{i,t} = \beta_0 + \beta_1 Internet_{i,t} + \sum_{k=3}^{n} \beta_k X_{k_{i,t}} + \theta_i + \epsilon_{i,t}$$

where for country i in year t, IS stands for the informal sector size as % of GDP, Internet for the internet usage, $X_{k_{i,t}}$ are various control variables included in the regression. Moreover, θ_i represents the country fixed-effects and $\epsilon_{i,t}$ is the error term. Notice that, since the series % of individuals using ICTs is only available for a cross-section of countries, report the heteroskedasticity-consistent least-squares estimator when I use this variable as the dependent variable.

Table 2 reports estimations for the whole dataset. Here, in total I run 8 regressions using different sets of independent variables in each. Regression (7) does not use the interaction variable, as once both taxes and productivity are included among the independent variables, the variance inflation factor gets disturbingly large for the interaction variable. This is not surprising considering the findings reported in the next subsection. Moreover, I also run regression (8) to understand the contribution of the interaction term to the regression. What I observe is that the association between internet usage and informal sector size significantly interacts with GDP per-capita. Since the coefficient of internet usage is consistently negative and the coefficient of the interaction variable between internet and GDP per-capita is consistently positive, I conclude that internet usage and informal sector size are negatively correlated with each other; however as GDP per-capita increases this negative correlation is reduced. Moreover, considering the range of the GDP per-capita series I use and the magnitude of the estimated coefficients of internet usage and the interaction variable, I see that, at higher GDP per-capita levels, it even can become positive.

Table 2: Informal Sector and Internet Usage: All Countries

Dependent variable: IS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Internet	-0.07*	-0.06*	-0.06*	-0.06*	-0.03*	-0.02*	-0.01***	-0.03*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.005))	(0.01)
Censorship	0.02	0.03	0.05	0.09	0.13	0.07	0.05	0.05
	(0.10)	(0.11)	(0.11)	(0.12)	(0.10)	(0.11)	(0.11)	(0.10)
GDP	-0.58*	-0.61*	-0.60*	-0.58*	-0.27*	-0.20*	-0.04	-0.66*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
Internet • GDP	0.003*	0.003*	0.003*	0.003*	0.002*	0.001*		
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		
Democracy		-0.36*	-0.35*	-0.35*	-0.36*	-0.20*	-0.22*	
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	
Bureaucratic Quality			-0.68*	-0.69*	-0.46**	-0.59*	-0.28	
			(0.19)	(0.19)	(0.19)	(0.16)	(0.23)	
Law and Order			0.05	0.04	-0.16**	-0.04	-0.09	
			(0.07)	(0.07)	(0.07)	(0.07)	(0.09)	
Openness				-0.004	-0.003	-0.0003	-0.002	
				(0.003)	(0.003)	(0.002)	(0.002)	
Productivity					-13.99*	-12.85*	-13.32*	
					(0.96)	(0.90)	(1.11)	
Government Spending						0.12		
						(0.02)		
Urbanization						-0.31*	-0.24*	
						(0.03)	(0.03)	
Tax							0.32**	
							(0.15)	
R-squared	0.32	0.36	0.37	0.37	0.48	0.55	0.56	0.25
Observations	1339	1157	1157	1149	1140	1101	671	1339
F-Test	186.05	143.25	98.67	84.93	117.56	118.73	65.41	179.09

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

Other than the internet usage and GDP per-capita, significant factors affecting informality in a robust way are democratic accountability, productivity (TFP), urbanization and taxes. In each case, the signs of the estimated coefficients are as expected.

In order to check the robustness of the results presented in Table 2, I conduct two

Table 3: Informal Sector and Internet Usage: MENA and Latin America

Dep.var.: IS

	Latin				MENA			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Internet	-0.11*	-0.10*	-0.10*	-0.09*	-0.09*	-0.06*	-0.08*	-0.07*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Censorship	-0.07	-0.09	-0.09	-0.10	-0.10	-0.06	-0.10	-0.11
	(0.23)	(0.25)	(0.26)	(0.26)	(0.19)	(0.19)	(0.19)	(0.19)
GDP	-1.20*	-1.21*	-1.30*	-1.29*	-0.26	-0.24	-0.40**	-0.27***
	(0.15)	(0.16)	(0.16)	(0.16)	(0.18)	(0.18)	(0.16)	(0.14)
Internet • GDP	0.003*	0.002**			0.003*	0.002**		
	(0.001)	(0.001)			(0.001)	(0.001)		
Democracy	-0.07***	-0.08**			-0.06	-0.06		
	(0.04)	(0.04)			(0.08)	(0.09)		
Law and Order	0.01	0.02			0.02	0.05		
	(0.05)	(0.05)			(0.22)	(0.22)		
Openness	-0.03	-0.04			-0.01**	-0.01***		
	(0.10)	(0.10)			(0.005)	(0.006)		
Productivity	-7.65**	-7.29**	-7.32**		-12.71*	-13.18*	-12.92*	
	(3.70)	(3.60)	(3.55)		(1.60)	(1.62)	(1.90)	
Government Sp.		0.04***				0.06***		
		(0.02)				(0.03)		
Tax			0.38**				0.41*	
			(0.15)				(0.13)	
R-squared	0.45	0.50	0.42	0.33	0.73	0.73	0.74	0.50
Observations	194	194	156	209	190	186	107	199
F-Test	61.19	52.29	30.63	34.12	61.21	53.75	40.57	33.10

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

sets of exercises. In one, I run the same regressions for different regions instead of the using the whole dataset. For that purpose, I divide my dataset into 5 regions: Middle East and North African (MENA), Latin American and Caribbean (shortly Latin), OECD-EU and Asian-Australian (shortly Asia) economies finally others which mostly consist of Subsaharan countries.[5] Next, I also run regressions using 3 different internet diffusion

[5]For space constraints I only report results for the first four regions; however estimation results with Subsaharan countries qualitatively give similar results. These are available upon request from the author.

variables as the relevant independent variable.

In Table 3 I report results of the estimations with the MENA and Latin American Economies. [6]. Again, here in total I run 8 regressions, 4 regressions for each region[7], using different independent variables in each. As it was the case in Table 2, the association between internet usage and informal sector size interacts with GDP per-capita. Moreover, again the same story applies here and the negative correlation between internet usage and informal sector size is reduced as GDP per-capita increases. Other than the internet usage, productivity and taxes are significantly correlated with shadow economy size for both regions. Moreover, openness seems to matter for MENA region whereas more democracy is significantly associated with smaller shadow economy for Latin American economies.

I obtain similar results for the subsets of OECD-EU and Asian economies. Regressions results for these subsets are presented in Table 4. Moreover, again, productivity and taxes have significant coefficients with expected signs for both regions.

Next, in Table 5 I present results of the second robustness check in which as indicated above I use different proxies for internet diffusion. Here, in total I run 6 regressions, 2 for each different dependent variable. In all these regressions, the signs of coefficients of the internet usage variable and its interaction with GDP per-capita are qualitatively similar, supporting the main hypothesis I have constructed in the second section of the paper.

3.3 System Estimations

The estimations I have presented in the previous section show how GDP per-capita interacts with the effect of the internet usage on shadow economy size. Specifically, results indicate that a higher degree of internet diffusion is associated with smaller shadow economy size and this effect is stronger in developing economies.

[6]To avoid high collinearity in these regressions, I do not use urbanization here as a control variable.

[7]Again, two regressions for each region do not use the interaction variable, as once both taxes and productivity are included among the independent variables, the variance inflation factor gets disturbingly large for the interaction variable. See the next section for why this is not surprising.

Table 4: Informal Sector and Internet Usage: OECD-EU and Asia

Dep.var.: IS

	OECD-EU				Asia			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Internet	-0.03*	-0.04*	-0.04*	-0.03*	-0.10*	-0.09*	-0.08*	-0.08*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Censorship	0.02	0.02	-0.02	-0.03	-0.10	-0.10	-0.07	-0.07
	(0.02)	(0.02)	(0.03)	(0.03)	(0.10)	(0.10)	(0.08)	(0.09)
GDP	-0.99*	-1.02*	-1.10*	-1.09*	-1.47*	-1.42*	-0.40**	-0.27***
	(0.15)	(0.16)	(0.16)	(0.16)	(0.18)	(0.18)	(0.16)	(0.14)
Internet • GDP	0.002**	0.002**			0.005*	0.005*		
	(0.001)	(0.001)			(0.001)	(0.001)		
Democracy	0.01	0.01			-0.10	-0.09		
	(0.02)	(0.02)			(0.10)	(0.10)		
Law and Order	0.03	0.03			0.04	0.04		
	(0.01)	(0.01)			(0.09)	(0.10)		
Openness	-0.02	-0.01			0.03	0.03		
	(0.07)	(0.07)			(0.02)	(0.02)		
Productivity	-5.90*	5-.92*	-5.12*		-8.71*	-8.68*	-8.92*	
	(1.50)	(1.50)	(1.55)		(2.12)	(2.12)	(1.87)	
Government Sp.		0.03				0.09***		
		(0.02)				(0.05)		
Tax			0.30**				0.21**	
			(0.14)				(0.10)	
R-squared	0.34	0.35	0.29	0.23	0.49	052	0.44	0.40
Observations	226	225	140	229	140	139	68	159
F-Test	41.08	38.19	40.36	35.120	50.12	33.57	34.90	30.10

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

Now, an immediate question that I can ask at this point is, why there is such a difference between developing and developed economies. The theoretical hypothesis I have developed in the section of the paper sheds light on this question. The hypothesis is that there are two opposing effects of internet diffusion: the productivity effect and the tax-evasion effect. In this subsection, I conduct several systems estimations to find support for the existence of these two effects.

Table 5: Informal Sector and Different Internet Usage Variables

Dependent variable: IS

	(1)	(2)	(3)	(4)	(5)	(6)
Broadband	-0.17*	-0.16*				
	(0.04)	(0.04)				
Wired			-0.10**	-0.09**		
			(0.04)	(0.04)		
% Indiv.					-0.13**	-0.13**
					(0.06)	(0.06)
Censorship	0.04	0.03	0.03	0.03	0.02	0.02
	(0.09)	(0.09)	(0.10)	(0.10)	(0.05)	(0.05)
GDP	-0.58*	-0.61*	-0.60*	-0.58*	-0.27*	-0.26*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Internet • GDP	0.002**		0.003*		0.004*	
	(0.001)		(0.001)		(0.001)	
Democracy	-0.30*	-0.29*	-0.33*	-0.37*	-0.16	-0.12
	(0.05)	(0.05)	(0.05)	(0.05)	(0.15)	(0.15)
Bureaucratic Quality	-0.60***	-0.59***	-0.47	-0.44	-0.98	0.93
	(0.34)	(0.34)	(0.30)	(0.30)	(0.60)	(0.60)
Productivity	-10.75*	-10.80	-11.12*	-11.20*	5.61**	-5.42**
	(1.00)	(1.00)	(1.12)	(1.12)	(2.66)	(2.66)
Government Spending	0.21	0.20	0.15	0.13	0.02	0.05
	(0.18)	(0.18)	(0.15)	(0.15)	(0.17)	(0.17)
R-squared	0.30	0.24	0.37	0.27	0.40	0.26
Observations	1109	1109	1040	1040	71	71
F-Test	56.10	50.99	67.19	61.49	39.70	35.14

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

To be able to separate the two distinct effects of internet diffusion, I estimate the following system of equations again in a panel-data setting:[8]

[8]I only report systems estimation results for internet users per-capita as the relevant independent variable. However, systems estimation results using other proxies for internet diffusion are available upon request from the author.

Table 5: System Estimations 1[e]

	All Countries			MENA		
Dependent Variable	IS	TFP	Tax	Informal	TFP	Tax
Independent Variables						
TFP	-2.69*			-5.87*		
	(0.34)			(1.95)		
Tax	0.24*			0.52*		
	(0.02)			(0.08)		
Democracy	0.14			-0.29**		
	(0.25)			(0.14)		
Bureaucratic Quality	-4.84*			-2.08*		
	(0.13)			(0.99)		
Internet		0.11*	0.03*		0.01*	0.05**
		(0.01)	(0.01)		(0.002)	(0.02)
Government Spending			0.48*			0.01*
			(0.04)			(0.004)
Urbanization		0.19***			0.008*	
		(0.10)			(0.001)	
GDP		0.18*	-0.15*		0.15**	0.07*
		(0.02)	(0.04)		(0.07)	(0.01)
Internet • GDP		-0.001*	0.01*		-0.03*	0.70*
		(0.00)	(0.00)		(0.01)	(0.09)
R-squared	0.62	0.70	0.21	0.56	0.57	0.40
Observations	671	671	671	96	96	96

[e]Robust z-statistics are in parentheses. ***, **, * denote 1, 5, and 10% confidence levels, respectively. In all regressions, a constant is also included but not reported.

$$IS_{i,t} = \beta_{1_0} + \beta_{1_1} TFP_{i,t} + \beta_{1_2} Tax_{i,t} + \sum_{k=3}^{n} \beta_{1_k} X_{k_{i,t}} + \epsilon_{1_{i,t}}$$

$$TFP_{i,t} = \beta_{2_0} + \beta_{2_1} Internet_{i,t} + \sum_{k=2}^{n} \beta_{2_k} Z_{k_{i,t}} + \epsilon_{2_{i,t}}$$

$$Tax_{i,t} = \beta_{3_0} + \beta_{3_1} Internet_{i,t} + \sum_{k=2}^{n} \beta_{3_k} Y_{k_{i,t}} + \epsilon_{3_{i,t}}$$

Here, again IS stands for the informal sector size, TFP for total factor productivity, Tax for taxes, X, Y and Z for different sets of independent variablesϵ's for error terms. I

use one-way random effect estimation of seemingly-unrelated regressions.

Results of the system estimations are presented in Table 5 for the whole dataset and MENA region and in Table 6 for the OECD-EU and Latin American economies. Noticeably, results support the theoretical hypothesis I suggested. Specifically, higher internet usage is associated with both higher productivity and higher tax burden on the formal economy (due to higher tax evasion). Moreover, as GDP per-capita increases the positive effect of internet on productivity decreases whereas the positive effect on taxes increases, in line with the theoretical framework I provided. As higher taxes are associated with larger and higher TFP is associated with smaller shadow economy size, these systems estimations show a possible mechanism why the negative effect of internet diffusion on shadow economy size is stronger in developing economies. The reason is that the productivity effect is stronger and the tax evasion effect is smaller in developing countries.

4 Concluding Remarks and Discussion

In this paper, I explored the relationship between the degree of internet usage and the size of the shadow economy using different panel data sets. Estimation results, which are robust to different econometric specifications, inclusion of various control variables and stratifications of the data, indicated that the association between internet usage and shadow economy size strongly interacts with GDP per-capita. Moreover, I also suggested and then empirically tested an economic mechanism to account for this observation. Specifically, I have highlighted two opposing effects of internet usage on shadow economy size, one increasing productivity and thereby reducing shadow economy size and another one increasing tax evasion thereby increasing shadow economy size. As the productivity effect is stronger in developing economies, whereas the tax evasion effect is more pronounced in developed ones, the effect of internet diffusion interacts with GDP per-capita.

A couple of policy recommendations emerge from the results presented above. When

Table 6: System Estimations 2[e]

	Latin			OECD-EU		
Dependent Variable	IS	TFP	Tax	Informal	TFP	Tax
Independent Variables						
TFP	-7.69**			-3.19**		
	(3.34)			(1.55)		
Tax	0.39**			0.12*		
	(0.15)			(0.04)		
Democracy	-0.08**			0.01		
	(0.04)			(0.02)		
Bureaucratic Quality	-3.14*			-3.08*		
	(1.03)			(1.02)		
Internet		0.07*	0.02**		0.02**	0.08*
		(0.02)	(0.01)		(0.01)	(0.03)
Government Spending			0.17*			0.02*
			(0.05)			(0.01)
Urbanization		0.02***			0.03***	
		(0.01)			(0.02)	
GDP		0.10*	-0.15*		0.15**	0.07*
		(0.03)	(0.04)		(0.07)	(0.01)
Internet • GDP		-0.003*	0.02*		-0.02*	0.12**
		(0.00)	(0.00)		(0.01)	(0.05)
R-squared	0.62	0.70	0.21	0.56	0.57	0.40
Observations	156	156	156	140	140	140

[e]Robust z-statistics are in parentheses. ***, **, * denote 1, 5, and 10% confidence levels, respectively. In all regressions, a constant is also included but not reported.

designing economic policy towards the shadow economy, policy makers should take into account how internet usage is associated with the size of the shadow economy. Moreover, considering that internet usage potentially has two effects on the shadow economy, one through productivity and other through taxes, policy should be designed taking these two opposing effects into account and measures should be taken to put the productivity enhancing effect forward relative to the tax evasion effect. Government policies towards subsidizing ICT investment and better infrastructure, improving institutions, especially the fiscal ones and the bureaucratic quality are among the steps needed to be taken by governments.

Surely, I do not make any claims here that the mechanism I suggested and tested is the only possible one allowing for the the association between internet usage and shadow economy to interact with GDP per-capita. A more detailed analysis should look at various other potential mechanisms as well. Moreover, one particular setback of the paper is that the data used in the empirical analysis is highly aggregate. Looking at the data in the microeconomic level, e.g. using firm or household level data, would shed more light on the economic mechanisms suggested in the paper. However, these I leave to future work.

Appendix

List of Countries in the Whole Dataset:

Albania, Algeria Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Belarus, Belgium, Belize, Benin, Bolivia, Bosnia, Botswana, Brazil, Bulgaria, Burkina Faso, Burma(Myanmar), Brundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Democratic Republic of Congo, Republic of Congo, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea Bassau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, india, indonesia, Iran, Ireland, Israel, Italia, Ivory Coast, Jamaica, Japan, Jordan, Kazakhstan, Kenya, South Korea, Kuwait, Kyrgyzstan, Laos, Latvia, Lebanon, Lesotho, Libya, Lithuania, Luxemburg, Macedonia, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Nigeria, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Suriname, Swaziland, Sweden, Switzerland, Syria, Tajikistan, Tanzania, Thailand, Togo, Trinidad ve Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States of America, Uruguay, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe

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