ICTs and the informal economy: mobile and broadband roles

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Abstract

Purpose – *The purpose of this paper is to explore whether information and communication technologies (ICTs) can move people from the informal to the formal sector. ICTs being multipurpose technologies can provide people with information about education, employment opportunities and government services that may potentially allow them to migrate to the formal sector.*

Design/methodology/approach – *The model includes variables that researchers have found to contribute to the growth of informality, such as the state of the economy, the impact of excessive taxes, the impact of regulation, the level of poverty and, of course, ICT metrics, specifically access to both cell phones and broadband as the main two mechanisms through which individuals in the informal sector can obtain information. The analysis relies on a multiple indicators and multiple causes statistical model, to evaluate the hard-to-measure informal economy. A panel data set of 170 countries covering a period of five years was used.*

Findings – *It was found that ICTs empower people, but such empowerment is not always positive for society. So, while mobile phones reduce transaction costs of informal business, this leads to their growth, as they are only a coordination technology. The empowerment that comes from broadband, meaning greater and deeper access to information and resources, can help reduce this sector of the economy and potentially improve these individuals' lives as well.*

Research limitations/implications – *Measurement of the informal sector is a challenge to researchers precisely because it is hidden. This, like other work in this area, relies on estimates from indirect measures of the informal sector. The results are to be interpreted with caution. In addition, given that this research relies on country-level data, any specific policy decision will have to take particular circumstances into consideration to adapt these results to a specific context.*

Practical implications – *This study is important because of the more nuanced effect found between narrow and broadband technologies with respect to the informal economy and because of its policy implications. Given the results, governments should consider broadband as an additional tool to help individuals make the transition from the informal to the formal sector.*

Social implications – *Once an individual who works in the informal sector begins to realize the advantages of moving to the formal sector, it with the help of ICTs. This awareness could potentially lead to a slow but steady migration away from the informal economy that can improve the economic conditions of the population in these countries.*

Originality/value – *Scholars up to this point have been quite enthusiastic about the benefits of ICTs. In this paper, it was found that the effects are not always positive; a mobile does not help people move away from poverty and, in fact, supports the informal sector. It was found that only broadband can help these entrepreneurs move into the formal sector.*

Keywords *ICTs, Informal economy, Transaction costs, Mobile, Broadband, Coordination technologies*

Paper type *Research paper*

Juan[1] is the head of a small household consisting of himself, his wife and his two children. He sells pirated CDs on the streets of Bogotá. He was forced into this situation after losing a previous job as a truck driver and was unable to find a job because of his lack of education. His current income is US$ (PPP) 7,748 a year. Up to this point, he has been unable to afford a mobile phone, but he recently decided that it might be a worthwhile

Received 4 February 2016
Revised 29 July 2016
Accepted 7 October 2016

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investment, as some of his friends in the informal sector have mobile phones, which seem to make running a business easier.

While there have been numerous efforts, mainly by economic researchers, to try to identify the sizes and causes of informal economies (Castells and Portes, 1989; Comola and De Mello, 2011; De Soto, 1989; Gërxhani and Van de Werfhorst, 2013; ILO, 2012; Leal Ordóñez, 2014; Loayza, 1997; Rama *et al.*, 2013), few have explored the impact that information and communication technologies (ICTs) have on these shadow economies at the macro level. This is particularly important at this time, for two reasons. One is the fact that ICTs are becoming more prevalent in our lives, including in less-developed countries. Mobile phone penetration has increased substantially, and both mobile connectivity and broadband connectivity have become important objectives for many governments, as is evident by ubiquitous universal service programs and, more recently, their national broadband plans and digital agendas. In Brazil, for example the National Broadband program included among its five objectives the aim to expand access to broadband and promote digital inclusion (Jensen, 2011). In Sri Lanka, the e-Sri Lanka initiative is the primary government effort to expand access through *Nensala*, or knowledge centers, through subsidies (Galpaya, 2011). In Morocco, the Government's Digital Morocco also includes among its four main strategic priorities broadband expansion and computerization across small and medium enterprises (Constant, 2011). The other reason is that these technologies have the potential to serve as tools promoting "re-entry" to the formal sector, which can be added to the many other recommendations that scholars have made about this problem (Perry *et al.*, 2007). ICTs are general-purpose technologies that have the potential to reduce barriers to entry for more complex businesses and to reduce the size of the informal sector. Given the accessibility and capabilities of ICTs, can they, in fact, help to reduce the informal economy?

Understanding the informal sector is critical because, as the literature indicates, it reflects the economic circumstances and political conditions of a country. It is a reflection of a government's inadequate institutional arrangements, and, to a certain extent, its inability to target poverty effectively. It should be noted, nonetheless, that these activities may be technically illegal, but perhaps not because they are dangerous, entail coercion, addiction or clandestine operations that negatively affect individuals and society, but because the institutional arrangements are such that these informal operations fall outside the purview of a legal framework, which in itself may not necessarily be legitimate (Centeno and Portes, 2006). Impediments to formal entry could be laws and regulations relating to trade, labor, establishment of new firms and environmental compliance that involve significant costs to potential commercial operations, making participation in the informal economy more attractive (Portes, 1994). In other words, the costs imposed by laws and regulations, by the bureaucracy associated with them, and by personal limitations, generate such significant costs that they force entrepreneurs to start and continue operations in the informal economy.

This paper's econometric analysis found that mobile technologies, in fact, exacerbate the problem, as they are primarily a coordination technology that facilitates connections with other people, whereas broadband appears to have the desired benefit of reducing the size of the informal sector.

We will use the story of Juan, introduced above, to present the literature about the informal economy and its causes, which will then be used to develop the econometric model, and we will conclude with policy recommendations.

What is informality?

Juan has a network of friends who also work in the informal sector. Some of them have small enterprises that operate informally; others do not own their own enterprises, but are

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employed by an informal entity. Curiously, he also has friends who work informally for small companies that are not part of the informal sector (ILO, 2012).

An enterprise is considered to belong to the informal sector when it is not registered under the specific legal frameworks associated with the operations of such an entity. These can involve the registration of the entity, tax or social security filings, labor requirements, permits to operate and so forth (Castells and Portes, 1989). While these enterprises are illegal, they are considered, by the population, to be legitimate operations (Webb *et al.*, 2009), with some scholars defining these individuals as self-employed (Heemskerk, 2003; Loayza and Rigolini, 2011; Williams, 2005)[2], and others considering them as entrepreneurs (Webb *et al.*, 2013; Webb *et al.*, 2009) that recognize and exploit opportunities (Bygrave and Hofer, 1991). In a more broadly defined manner, they also involve, as Chen (2007) indicates, labor without labor or social protection.

Even though this is not a desirable situation, because of the vulnerability of these enterprises and their inability to take people out of poverty, they provide significant economic activity for both the people involved and the country. According to Schneider (2002), they amount to 10 to 20 per cent of the GDP in some developed economies and up to 60 per cent in developing countries. They thus provide a livelihood, even if sparse, for millions of people, and because of this, their role in the economic development is controversial. Some scholars (Chen, 2007; Maloney, 1999; Webb *et al.*, 2009) believe that they should be viewed as a basic component of an economy, a feature of capitalism in which individuals are exhibiting a spirit of entrepreneurship. People in the informal economy, as Perry *et al.* (2007) indicate, may be providing marginally better working conditions, namely, flexibility and autonomy, when the alternatives in the formal sector are equally bad.

Others, more skeptical about these shadow economies (Marcouiller and Young, 1995; Porta and Shleifer, 2008), find the sector to be too small, with a lack of protection of property rights, and believe that these entities and individuals undermine tax collection and negatively affect the ability of governments to provide public goods (Ihrig and Moe, 2004). In international organizations like the World Bank, the informal economy is perceived to be a problem, also because of the lack of labor protection and the perpetuation of poverty (Cling *et al.*, 2014). There is also the suggestion that the presence of informal vendors may slow down the process of creative destruction by which small and inefficient firms are replaced by more efficient competitors, interfering with incentives for the larger firms to become more innovative (Perry *et al.*, 2007).

Individuals and informality

At any given point, a person like Juan will need to weigh the costs and benefits of entering the formal economy, taking into consideration the time, effort and costs that this would entail in addition to his own capabilities. This is well recognized in the new institutional theory that emerged from the work of North (1990) and subsequent scholars (Clemens and Cook, 1999), who have found that institutions provide individuals with incentives they will then exploit to engage in activities that benefit or move their interests forward. In many countries, the prevailing institutional arrangements, from an individual's point of view, may make engaging in activities within the informal sector more viable.

People find the informal sector to be an attractive source of income because entry is easy; it requires little capital and equipment; it can easily accommodate a small, one-person operation; and the skills required are low (Charmes, 2000; Mondragón-Vélez and Peña, 2010).

The factors that make entry into the informal sector easy, as Leal Ordóñez (2014) indicates, negatively affect economic growth in the form of significantly lower labor productivity or, as Johnson *et al.* (1998) found, they reduced state revenues, and this, in turn, reduced the

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quality and quantity of public services. These informal enterprises do not pay taxes, have little potential for growth and development, constitute unfair competition to small formal business (Rama *et al.*, 2013) and contribute little to capital or knowledge creation. They are not under the purview of labor regulations because they are small and want to remain hidden from government scrutiny (Rama *et al.*, 2013). These are mainly subsistence operations that keep those in the lowest strata of income levels alive. The problem of informality is exacerbated by population growth, migration from rural areas, poverty and indebtedness (Charmes, 2000).

Because Juan operates illegally, he has had to pay significant penalties for selling on the streets, and he often has to bribe the police to avoid having his stock confiscated. This can amount to 10 to 15 per cent of his gross income, compared to the 1 per cent on average that official companies in Peru pay for bribes (De Soto, 1989; Ghersi, 1989).

Because he is not legally established, Juan is poorly protected by the police and the courts from crimes committed against his property, or from contract violations, and he is unable to obtain any type of business insurance (Loayza, 1997).

Operating in the informal sector provides some basic business skills. A few years ago, Juan wanted to expand his operations, but because of the nature of his business, he was unable to obtain capital from either the private sector or government sponsorship. Given their high-risk operations, informal companies like Juan's find it difficult to access capital, and when they do, the interest they pay is significantly higher than that in the formal sector, 22 and 4.9 per cent, respectively, in Peru, in 1985 (De Soto, 2003). A study in Bangladesh found similar disparities in the interest rate paid for capital, between 48 and 100 per cent for informal versus 12 per cent on average for formal entities (Huq and Sultan, 1991). Individuals who work in the informal sector remain poor because the income that they generate from their efforts is low (Charmes, 2000). This is in part because entities in the informal sector remain intentionally small because of the fact that more capital-intensive firms can be more easily detected (Loayza, 1997). In fact, many of these individuals work within their home to avoid detection from the government (Fernandez-Kelly and Garcia, 1989). Research from Perry *et al.* (2007) shows that as firms get larger, they are more likely to become part of the formal sector. In fact, his study shows a dramatic decrease in the percentage of firms that are part of the informal sector if they have five or more employees (Loayza, 1997).

Some of Juan's friends who work informally for formal companies have often been abused with poor working conditions and low wages, and they fear being laid off at any moment. Laborers in the informal sector are poorly protected; they have no formal labor contracts and rarely have the opportunity to improve their skills through formal training (De Soto, 1989; Loayza, 1997; Orlando, 2001).

Factors that lead to informality

Given the challenges and difficulties that people face when working in the informal sector, one must ask why it is that individuals like Juan opt to work under these uncertain conditions. As Amuedo-Dorantes (2004) indicates, employment in the informal sector can be supply-led – that is, individuals opt to work in the informal economy because, given the value of their marginal income in the formal versus the informal sector, they have determined that they can make slightly higher earnings working in the informal sector.

An alternative reason is because their specific personal characteristics, or institutional barriers, make it difficult for them to find a job in the formal sector (Dobson and Ramlogan-Dobson, 2012). This explanation points to a demand-led rationale, by which individuals find it difficult to secure employment or start a company.

Sadly, while informal employment may provide some means of survival, it is by no means a panacea, as the households involved are more likely to slip down into poverty even more.

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According to Amuedo-Dorantes (2004), employment in the informal sector increases the likelihood of poverty by 8 per cent for male-headed households and by 4 per cent for female-headed households.

Consequently, poor individuals like Juan, finding themselves in difficult, if not desperate, economic circumstances, are forced to engage in economically unproductive activities that generate a minimum survival income. The prospects for them to grow personally and professionally are minimal, unless concerted efforts are made by governments to train this segment of the labor force, as is suggested by Adams *et al.* (2013). The hope is thus to provide more opportunities, including education, for people, so they can find employment in the formal economy. Research on the informal sector in Africa, shows that people working in the informal sector and agriculture also have the lowest level of education. Adams *et al.* (2013) have shown a significant correlation between education and training, and the type of job held. The next sections of this paper present factors identified by scholars that can push people into the informal sector. We begin with the variable of interest: ICTs.

ICTs

In a previous study (authors, 2013), we found that ICTs positively affected the creation of new businesses. The rationale for this relationship was that information technologies remove the barriers to entry, while also providing sector information, business skills information and access to the collective wisdom of many users willing to share their experience and expertise in any given area.

In that study, we did not include the informal sector, mainly because we believed that individuals employed in the informal economy did not contribute to the capital accumulation and economic growth of a nation.

Some of these informal enterprises, however, exhibit great sophistication, enabling owners and the small group of informal employees that they work with to operate under better conditions for themselves (Amuedo-Dorantes, 2004). In that study, we considered only two technologies: cell phones and internet broadband access. We included cell phones because, in developing nations, they are the preferred mode of access to communication, although more recently, governments are beginning to realize the importance of broadband, because of the many more options (i.e. government services, education, business operations) that faster internet access can provide (OECD, 2016). (To clarify, the term *cell phones* in this paper refers to telephone subscriptions that provide voice communication services only). *Broadband* refers to subscriptions to fixed high-speed access to the internet. We recognize, nonetheless, that bandwidth on cell phones is increasing as penetration continues to growth. While these connections are, at the moment, the preferred and often the only option for broadband in developing countries, growth in mobile broadband demand will be limited by spectrum scarcity.

ICTs, we believe, have the potential to reduce barriers to information, providing access to job opportunities, government programs, training and business resources, which may be necessary if Juan is to formalize his operations.

There have been multiple efforts by governments to try to reduce the size of the informal sector. This is because informal entities use government services but do not fully contribute to their provision. This, in turn, negatively affects the provision of more and better services, such as basic infrastructure. This leads to a vicious circle of informality and poor government services (Ihrig and Moe, 2004).

The question now is whether ICTs implemented by the government and used by individuals like Juan can move these informal entrepreneurs from the informal to the formal economy by reducing some of the barriers associated with the government.

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In the past five years, ICTs have developed rapidly. Some of these technologies have been implemented by governments in an effort to make their operations more efficient (Torero and Von Braun, 2006). This, we believe, will contribute positively to the reduction of the informal sector.

While ICTs can have a potentially beneficial role in reducing the size of the informal sector, the model needs to control for other factors that scholars have found to contribute to this problem. The next few sections present these.

Burdensome bureaucracies

Regulation, ideally conceived, is intended to protect society from the negative effects of the market, such as pollution and health and safety hazards. It protects employers by limiting their liability when problems with a product arise, by preventing their assets from being stolen, and by securing them from fraudulent activities on the part of employees and from exploitative labor practices and salaries. It also provides benefits for employees, such as social security, paid vacations, sick leave and protection against unjustifiable firing. It protects consumers from dangerous products and services (Guasch and Hahn, 1999).

Regulation, nonetheless, can be intrusive and overwhelming to the point of discouraging entry or forcing employers to hire people informally so they can avoid paying the costs for labor compliance, for example (Mazumdar, 1976).

When Juan was ready to enter the formal sector with an electronics store, he found it impossible to accomplish this. He faced bureaucratic barriers involving government officials requiring him to comply with complex and often corrupt processes that entailed significant license or registration fees, and he would have had to visit multiple government offices (Loayza, 1997). He probably realized that these difficulties were not going to end after he started his business because there were so many legal and procedural requirements that had to be complied with, it would be difficult to remain legal once he started operations.

In a now-famous study by De Soto (1989), the registration of a firm in Peru was found to take 10 months and cost an estimated $1,037 in loss utilities, equivalent to 32 times the minimum monthly salary, and it included $195 for licenses and other regulatory requirements. This was later compared with two cities in Florida in the USA, where it took 3.5 h, and in New York City, where it took 4 h to register a new firm. More recent research, however, has also shown that individuals may also fail to register their operations because of ignorance about the law, rather than because of a deliberate intention to escape corruption (Lavallee and Roubaud, 2014).

In many developing countries, excessive regulation is common, and many researchers have attested to this. In the Philippines, for example, even micro-enterprises require a lawyer and an accountant to comply with all regulatory requirements (Alonzo, 1991). In Egypt, as observed by Chickering and Salahdine (1991, p. 191), "much of the country's entrepreneurial talent is consumed in circumventing the country's nightmare bureaucratic regulatory system". In Eastern Europe and the former Soviet states, inadequate regulation and taxation, according to Johnson *et al.* (1997), led to the growth of the informal economy. In these countries, the Global Competitiveness Survey reports that a one-point increase on the 1-7 (higher is better) scale of regulatory discretion and tax enforcement rules led to a 9.2 percentage fall in the share of the informal economy (Johnson *et al.*, 1998).

Labor laws are complex pieces of legislation that regulate, among other things, the number of days of annual leave with pay, the number of days of maternity leave, social security contributions as a percentage of wages, minimum wage as a percentage of average wage and severance pay, all of which can be difficult to comply with, unless expert labor attorneys are hired to navigate the process of approvals, even under efficient government processes (Peña, 1999).

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A study of the informal sector in Mexico found that street vendors participated in their own organizations to take care of problems with the government (51 per cent of respondents) and to assign and negotiate spaces for the merchants (29 per cent of respondents). These organizations emerged as a means to overcome government regulations and red tape. It is much easier for these street vendors to become members of these organizations than to try to work within the purview of government oversight (Rama, 1995).

Street vendor organizations, at least in Mexico, are formed to manage stall locations, adjudicate conflicts among vendors selling similar products, maintain waiting lists, assign the use of space when a vendor is absent and even oversee the sale of informal "rights" for "rented" spaces to individuals who are leaving the market. These organizations are, in fact, alternative government structures (Peña, 1999).

In the presence of these alternatives, the cost of compliance in the formal sector, compared to the potential benefits obtained from joining, facilitates a person's decision to decide to become informal. As Perry *et al.* (2007, p. 7) indicate, "many entrants have no choice but to join the less desirable occupation in the informal sector".

For this study, we used the variable *cost of starting a business* as a proxy for bureaucracy.

Corruption

In addition to the bureaucratic processes that Juan had to comply with to move into the formal economy, he discovered that many of the requirements would have been impossible to fulfill without paying significant bribes. This was not a one-time situation; it would occur on a number of occasions in different government offices. Corruption is thus an additional barrier for individuals trying to move their operations from the informal to the formal sector (Lambsdorff, 1999). In this respect, North (1990) states that institutions influence economic activity. Citizens will engage in enterprises that generate the greatest economic returns. In many countries, the most lucrative activities are bribes, kickbacks and illegal favors; these generate serious negative distortions in the economy and undermine citizens' trust in the (democratic) institutions of the country, moving many of them into the informal sector. When a country experiences high levels of corruption, these illegal activities become institutionalized as part of the fabric of society.

For corruption to occur, one of the parties in the relationship must be able to give the other a privilege that would otherwise be difficult to get. Governments are thus one of the main sources of corruption, particularly those with big bureaucracies, because there are many activities within the purview of the state – in the form of licenses, permissions, contracts and so forth – directly controlled by a few powerful individuals in government.

Taxes

At the time when Juan was trying to expand his informal business, he also became aware of the taxes that he would have to pay to formally register his business. This is not surprising; there is evidence that an informal sector emerges when there are excessive taxes (Loayza, 1997). Taxes are an important source of income for governments, and given a lack of resources to enforce tax returns for individuals, companies become easy targets for extracting tax income. In developed countries, in 1993, the tax income from corporations amounted to only 7.6 per cent, which is almost a third of the tax rate that prevailed in developing economies, which was approximately 17.8 per cent (Burgess and Stern, 1993). This problem is exacerbated when a comparatively smaller corporate sector has to make up for unpaid taxes on the part of the informal economy, leading to higher taxes than in developed nations. It is thus not surprising to find that countries that experience high participation in the informal economy also experience high tax evasion (Schneider and Enste, 2000; Silvani and Brondolo, 1993).

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Education

Juan has heard from his friends that they have used the internet to get merchandise because they can find the cheapest outlets, and they can communicate with friends in other markets where the merchandise also is sold. Juan has not taken advantage of these technologies, but is curious about them.

A Colombian report (CCYT & Fedesarrollo, 2013) indicated that small businesses forwent the use of ICTs for two main reasons. One was the price associated with the use of these technologies; the other was that the businesses could not envision how to use them. This alerted us to the effect of education as a prerequisite for individuals in the informal sector to be able to take advantage of ICTs.

Gërxhani and Van de Werfhorst (2013) explored the connection between education and the informal sector. They found that education heightens the population's civic commitment, which may lead them to morally refuse to participate in the informal sector.

Although not directly addressing the connection between education and the informal sector, Štulhofer and Rimac (2002) found a positive correlation between education and opportunism, which they used as a proxy for the informal economy in Croatia.

Rogers' (1983) diffusion of innovations theory includes education as one of the factors that leads to technology adoption. Better-educated populations are quicker to adopt new technology than those with less education (Mintrom and Vergari, 1998). Similarly, Kelly and Petrazzini (1997) found that academic institutions play an important role in the diffusion of the internet because they are among the first to be connected (Evers *et al.*, 2005). A study by Maurizio (2014) found a significant correlation between informality and education. Workers in the informal economy have, on average, a lower level of education than their formal counterparts.

The effect of education is, nonetheless, not entirely clear. A study by Gërxhani and Van de Werfhorst (2013) found that education is only relevant to internet adoption when government policies are not included in the model.

At this point, it is unclear which ICTs will have the greatest impact on the reduction of the informal economy. Assuming that the internet is key to moving individuals away from the informal sector, its adoption might depend on a population having a fairly high level of education, unlike the adoption of cell phones, which require no education and which street vendors may prefer (Dasgupta, 2001).

Data and methods

Using data from the World Bank and other international organizations, we constructed a panel data set with 171 countries over a five-year period from 2007 to 2011 (see the description of variables and sources in Appendix). It should be noted that macro-economic data are imperfect. While international organizations like the World Bank, the ITU and other United Nations organizations have tried to standardize these measurements, governments ultimately report on the data, and their definitions may not be entirely consistent across the world. However, given that there are no alternatives, scholars rely on and conduct research on the basis of these data, but country-level decisions would require additional research to adapt these imperfect macro results to their specific circumstances. In addition, one of the main challenges in doing empirical international research is the lack of complete data. Because missing variables are a common problem, scholars have devised techniques to calculate missing variables from existing ones. In this study, we used a multiple imputation technique using Stata, which has been found to be superior to other alternatives (King *et al.*, 2001). The mathematical algorithms that are necessary for multiple imputation are now easier to use, thanks to advances in computing.

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Our statistical analysis relies on the Multiple Indicators and Multiple Causes Model (MIMIC)[3] when studying the informal sector to identify its causes and to test the significance of factors that could explain its size. In setting up the model, we relied on a latent variables technique, because informality, although observable, is not easily measured; there are no records about the individuals and entities involved, and they do not want to be found. Given that the estimation of informality was jointly captured for all of the countries in the sample, we were able to use these estimations of the size of the informal sector to verify that it corresponded to estimates done by other scholars who have studied these countries (Buehn and Schneider, 2012). The model was constructed on the basis of the theories identified in the literature review.

The MIMIC model is specified as follows:

$$I = \tau' X + \varepsilon \quad (1)$$

$$Z = \varnothing I + \mu \quad (2)$$

and $E(\varepsilon\mu') = 0$, $E(\varepsilon^2) = \sigma_\varepsilon^2$, $E(\varepsilon^2) = \Omega$, a diagonal matrix.

In equation (1), the latent variable *I* represents the informality variable, which was linearly determined by a set of exogenous factors, *X*, that identified ICTs, the bureaucratic process, corruption, taxation and education. Because informality cannot be directly observed, we had to find indicators that could explain this informality that could serve as proxies. For this, *Z* in equation (2) uses GDP per capita, infrastructure and the Human Development Index as indicators that can help determine the size of the informal sector within a country.

The reduced form of the model with equation (1) inserted into equation (2), is as follows:

$$Z = \varnothing(\tau' X + \varepsilon) + \mu \quad (3)$$

$$Z = \rho' X + \upsilon \quad (4)$$

The structural equations from the parameters (causes) use the maximum likelihood estimation method.

The model assumes that the latent variable *I* has a high correlation with the *Z* indicators and also solves the problem of endogeneity between the indicators and the causal variables.

Note that in equation (4), we have a nonlinear parameter. Therefore, it was necessary to normalize the variables – for instance, setting one of the coefficients in ∅ equal to one (constrained). Normalization of the latent variable could be achieved using the estimated values of the causal coefficients. Then we were able to compare the differences in the latent-variable values for the countries and, thus, rank all of them.

Results

Figure 1 reports the estimation results. The regression coefficients and their respective standard errors (in parentheses) are represented by the arrows pointing in the direction of influence in the model. In this case, the MIMIC model involved eight causal variables (*X*) and 3 indicators (*Z*).

In the regression, the determinants of the informal economy were used directly as explanatory variables. The informal size was measured as a per cent of GDP per capita.

We found that the coefficients of the explanatory variables were significant, except for the proxy variable for education (*public spending on education*). All of the explanatory variables presented the expected sign. The model predicts two important things: first, both of the ICTs included in the regression were shown to be significant. For mobiles, the model predicts that a 1 per cent increment in the number of subscribers will result in an increment of 0.025 per cent in the size of the informal economy. In the case of the broadband variable, the sign is negative, which means that, for a 1 per cent increase in the number of subscribers to fixed broadband, the economy will experience a reduction of the informal economy equal to 0.10 per cent of the GDP per capita.

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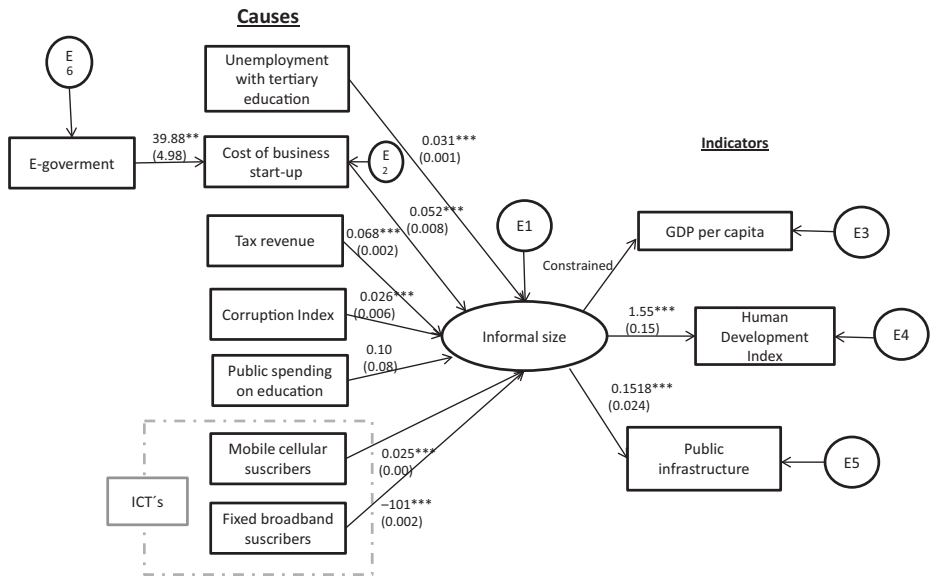
Figure 1 Analytical framework with regression results



Note: Standard errors in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$

As we indicated throughout the paper, the informal sector is the result of many and different governance failures. Because ICTs are general-purpose technologies, they have been shown to have a positive effect on development. However, the results of this study reveal a difference in the manner in which phones and broadband affect the informal economy. One technology supports its growth, while the other helps reduce it. This finding is significant because governments in less-developed countries have prioritized basic (i.e. voice) mobile connectivity over broadband, particularly in universal service programs. This is a sensible approach in particular for rural areas where broadband deployment is expensive and potentially unjustified. However, in cities with much higher population densities and locales where there are greater concentrations of informal workers, investment in broadband can be justified on the basis of the benefits it can bring to the economy by enabling the re-entry of individuals into the formal economy.

The impact that voice has in the informal economy, as opposed to broadband, points to a need to expand universal service programs to include high-bandwidth connectivity, which can be either fixed or wireless.

Note that our analysis of ICTs points to a picture slightly different from the one most commonly put forth by ICT scholars. Specifically, cell phones and broadband access have an impact on the size of the informal sector, although they fulfill different functions. First, cell phones are indeed an enabling technology, but the amount of information that a person can obtain through them is restricted to person-to-person interactions. The sign of this coefficient on the informal sector is positive and significant, meaning that an increase in the use of cell phones also increases the size of the informal sector.

This, to us, represents efficiencies, primarily in the form of a reduction of the transaction costs associated with coordination and, potentially, enforcement. A street vendor needs to be able to coordinate his or her operations with the people who provide salable goods and maintain communication with their peers to ensure that their property is not confiscated when law enforcement tries to shut down their operations. The prevalence of cell phones in

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less-developed countries, in the absence of broadband, actually aggravates the problem by making it easier to operate.

These results complement previous research on the impact of cell phones on the informal economy. A study by Molony (2008), who analyzed the impact of mobile phones on the informal construction sector in Tanzania, found that mobile phones make it easier for previous customers to locate and recommend their leader to other potential clients. Mobile phones were also found to be helpful for saving time, and money spent on traveling to communicate with suppliers, employers and clients. These are all coordination tasks. Molony also states that, at least in Tanzania, these workers lack marketing or commercial skills that the government has promised to offer.

We do not deny that mobile phones have been transformational and have positively affected developing economies. This is particularly true for many countries that started at zero connectivity less than 20 years ago; access to mobiles has allowed their populations to share information, from crop prices to weather and health information, and more recently, even to transfer money (Etzo and Collender, 2010).

The second technology we analyzed, broadband, has a negative and significant coefficient, showing that a greater diffusion of broadband helps to reduce the size of the informal sector. The effect is not only significant but also quite large. This provides some initial evidence of the positive effects that access to broadband can have on disadvantaged populations. Unlike cell phone technology, which appears to impact only business operations by reducing transaction costs, broadband gives people access to many more resources that can give them the means to find alternative employment options. These results are consistent with those of other studies that have shown that broadband allows individuals to acquire skills that can make them better prepared for the knowledge economy (Qiang and Rossotto, 2009). In the USA, communities that adopted broadband were found to experience faster growth in employment, in the number of businesses, and in businesses in the IT sector. One could even argue that newly emerging portals like Uber, Airbnb and, more important, TaskRabbit can help governments collect taxes from individuals who used to avoid tax payments because they sold their wares through friends, family and street customers.

Given that we are interested in the impact of technologies, we also explored the impact that electronic commerce has on bureaucratic processes – specifically, the cost of doing business. In other words, we wanted to find out if ICTs have reduced the burden of bureaucracy on individuals wishing to start a business. The variable is significant and positive, meaning that the introduction of technologies into the country has led to increases in the cost of starting a business. Although this is not what we would have expected, it is possible that today, when we are just at the beginning of the introduction of technology into government processes, businesses need to invest in technology as well and learn the new system, which might explain why the variable has a positive sign. This result is consistent with other studies that found that broadband in education, for example, has not yet shown a significant effect for educational performance (Hopkins, 2014), which could be attributed to the time it takes for institutions to establish supporting infrastructure, such as teacher training.

The model included other variables, all of which have been found to contribute to the existence of the informal economy. Of the variables that were significant, one the most influential was *taxes collected by the government*. Every time the government increases its tax revenues, the size of the informal economy increases. The model has the expected positive sign and predicts that a 1 per cent increase in tax revenue (as a per cent of gross national income) will result in a 0.068 per cent increase in the size of the informal economy.

This problem is exacerbated by the impact that other government variables have on the informal economy. For example, *the cost of doing business*, which was our proxy for

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bureaucracy, shows that, indeed, the higher the cost of doing business, the larger the informal sector. In regard to bureaucracies, as represented by the *procedures (or cost) to start a business*, we found that a 1 per cent increase in the cost to start a business will result in a 0.052 per cent increase in the informal sector (as a per cent of GDP per capita). If we think about the manner in which governments evolve, we are likely to find that procedures evolve, and their history or rationale fades, leading to the creation of bureaucracies, which, in turn, can lead to the prevalence of inefficiencies that open opportunities for corruption, all of which contribute to and further exacerbate the problem of informality. In this case, corruption is also a significant factor leading to an increase in the informal sector. If the corruption index goes up, the size of the informal sector increases significantly as well.

All of these government-related variables combined paint a grim picture of systemic problems that lead to the emergence of informal economic operations. We appear to have a government that gets its revenue from an inadequate tax structure, which, along with bureaucratic inefficiencies and corruption, further exacerbates the problem of the informal sector.

Finally, in regard to the outcome variables, we found that the informal economy affects GDP per capita positively, which is not surprising, because the income that these individuals generate from their informal operations gets spent in the formal economy. The model also shows that both infrastructure and human development are positively affected, but the degree is too small to be of great importance or concern.

Given the results of this study, we are optimistic about the positive impact broadband can have on an economy, which should lead to a reduction of the informal sector. However, these results do not suggest that deploying broadband will automatically reduce the size of the informal economy. Broadband should be considered as another tool that government can use to give individuals access to resources that can help them transition from the informal to the formal sector. The key, thus, is not only connectivity, but also accessible resources that enable a "re-entry" into the formal sector.

Conclusion

The results of this study led us to a different set of conclusions from those we started out to explore. Our initial hypothesis was related to the notion of individual empowerment, with the expectation that ICTs and the information that is available through websites would allow entrepreneurs to explore economic options outside of the informal sector. We found that ICTs do empower people, but such empowerment is not always positive. While mobile phones reduce the transaction costs of informal business, they lead to its growth. The empowerment that comes from broadband, meaning greater and deeper access to information and resources, can help reduce this sector of the economy and potentially improve these individuals' lives as well.

The emergence of the informal economy is a complex problem that involves many economic and political variables. It is clear that the informal economy has ties with the formal economy; hence, our decision to develop a model that included GPD per capita, HDI and public infrastructure as factors that affect the size of the informal sector. It is clear that the rate of unemployment pushes people into the informal sector. An increase in the rate of unemployment leads to a great increase in the size of the informal economy. This paper proposes an analytical model, whereby taxes, bureaucratic processes and corruption negatively affect the formal sector, so that educated people are unable to find employment, and expenditure for education does not appear to have any impact on the size of the informal sector.

For public officials in the ICT sector, efforts to expand broadband, along with efforts to improve the operations of government, can also help to shrink the country's informal economy.

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This study is also a macro-economic one, and the findings are intended to contribute to the literature. An understanding of the informal sector is indispensable in the fight against poverty. However, countries experience this problem in different contexts, with different factors that lead to the growth of this sector. Therefore, in designing policies for a particular country, investing in broadband can help alleviate the factors that are found to be most problematic and identify those that can contribute positively to a transition to the formal economy.

Notes

1. While Juan is a fictional character, the portrayal is sound, as much of the literature on the subject describes individuals who are similar to him.
2. It should be noted that there are informal firms that are larger than a single individual, while there are also self-employed people who are operating in the formal economy.
3. This method was proposed by Frey and Weck-Hanneman (1984). The MIMIC approach explicitly considers several causes, as well as the multiple effects, of the informal economy. For a good survey of the different methods applied in the literature; Vuletin *et al.* (2008).

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Appendix

Table AI Variable's definitions

Name	*Code*	*Description*	*Source*
Human Development Index (HDI) value:	hdi	A composite index measuring average achievement in three basic dimensions of human development – a long and healthy life, knowledge, and a decent standard of living	United Nations Development Programme
Fixed broadband Internet subscribers (per 100 people)	fbiphp	*Fixed broadband Internet subscribers* consists of the number of broadband subscribers with a digital subscriber line, cable modem, or other high-speed technology	World Bank[a]
Mobile cellular subscriptions (per 100 people)	mcsphp	*Mobile cellular telephone subscriptions* are subscriptions to a public mobile telephone service using cellular technology that provides access to a public, switched telephone network. Post-paid and prepaid subscriptions are included	World Bank[a]
GDPPC, PPP (constant 2005 international $)	gdppc	*GDP per capita based on purchasing power parity (PPP).* PPP GDP is gross domestic product converted to international dollars, using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the US dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy, plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. Data are in constant 2005 international dollars	World Bank
Tax revenue (% of GDP)	taxr	*Tax revenue* refers to compulsory transfers to the central government for public purposes. Certain compulsory transfers, such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue	World Bank
Infrastructure index	infrastructureindex	The Macquarie Global Infrastructure Index Series (MGII), calculated and managed by FTSE, is designed to reflect the stock performance of companies within the infrastructure industry, principally those engaged in the management, ownership and/or operation of infrastructure and utility assets. The index covers transport, telecoms equipment, oil & gas, electricity, multiutilities, gas distribution and water	
E-government index	egi	The E-Government Development Index is a composite index comprising the Web Measure Index, the Telecommunication Infrastructure Index and the Human Capital Index	UN Public Administration Programme
Procedures to build a warehouse (number)	pbw	The *number of procedures to build a warehouse* is the number of interactions of a company's employees or managers with external parties, including government agency staff, public inspectors, notaries, land registry and cadastre staff, and technical experts apart from architects and engineers	World Bank

(*continued*)

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Table AI

Name	*Code*	*Description*	*Source*
Unemployment with tertiary education (% of total unemployment)	uewte	*Unemployment by level of educational attainment* shows the unemployed by level of educational attainment, as a percentage of the unemployed in general. The levels of educational attainment accord with the International Standard Classification of Education 1997 of the United Nations Educational, Cultural, and Scientific Organization (UNESCO)	World Bank
Cost of business start-up procedures (% of GNI per capita)	cbsup	The cost to register a business was normalized by presenting it as a percentage of gross national income (GNI) per capita	World Bank
Control of corruption	corruption	*Control of corruption* reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as the "capture" of a state by elites and private interests	World-wide governance indicators
Effectiveness of government	Governance	This indicator measures the quality of public services, the quality of the civil service and its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to its stated policies	World-wide governance indicators

Note: [a]The World Bank data on the ICT sector use data from the ITU

Table AII Basic statistics table

CODE	*Median*	*SD*	*Minimum*	*Maximum*
Hdi	0.65440784	0.174658295	0.27	0.943
Fbiphp	8.24402255	8.409675177	1	37
Mcsphp	70.9895955	38.68694173	1	205
Pcphp	58.1808994	9.198302017	0	94
Gdppc	10850.8127	8577.484046	298	57073
Taxr	16.8680983	6.21518422	0.195383	58.8583
infrastructureindex	0.09048565	0.098422127	0.0017487	0.6390205
Egi	0.45457433	0.180222717	0.1142	0.9157
corrupt	37.1968296	23.37110527	1	97
Pbw	16.020936	6.475662879	5	45
Uewse	45.2156738	15.94595624	4.5	82.8000031
Informalsize	0.46530956	0.22437512	0	1
Senrollment	80.6848218	27.5581318	11.14075	155.0718

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Table AIII Correlation coefficients matrix

The correlation coefficient	*Informal size*	*Human Development Index (HDI) value*	*Fixed broadband Internet subscribers (per 100 people)*	*Mobile cellular subscriptions (per 100 people)*	*Personal computers (per 100 people)*	*Population in the largest city (% of urban population)*	*Tax revenue (% of GDP)*	*Infrastructure index*	*E-Government*	*Freedom from corruption*	*Procedures to build a ware-house*	*Unemployment with secondary education (% of total unemployment)*	*Secondary people/total*
Informal size	1.0000												
Human Development Index (HDI) value	−0.7320	1.0000											
Fixed broadband Internet subscribers (per 100 people)	−0.4934	0.5841	1.0000										
Mobile cellular subscriptions (per 100 people)	−0.4728	0.6579	0.5135	1.0000									
Personal computers (per 100 people)	−0.2335	0.2606	0.5396	0.1845	1.0000								
Population in the largest city (% of urban population)	−0.2565	0.2533	0.2825	0.2097	0.1705	1.0000							
Tax revenue (% of GDP)	−0.4503	0.3873	0.2309	0.2161	0.1345	0.1278	1.0000						
Infrastructure index	−0.4062	0.5071	0.3779	0.1629	0.1606	0.1552	0.1392	1.0000					
E-Government	−0.2384	0.3158	0.2858	0.2371	0.1428	0.0590	0.1173	0.1021	1.0000				
Freedom from corruption	−0.6759	0.5326	0.5543	0.3541	0.3164	0.2772	0.2809	0.4246	0.2103	1.0000			
Procedures to build a warehouse	−0.0456	−0.0093	−0.1679	0.0325	−0.1041	0.0138	−0.1299	−0.1260	−0.0040	−0.1398	1.0000		
Unemployment with secondary education (% of total unemployment)	−0.3374	0.2762	0.1803	0.2436	0.0103	0.1418	0.1668	0.0813	0.1540	0.1497	0.1138	1.0000	
Secondary people/total	−0.8831	0.6651	0.3772	0.4122	0.1898	0.1794	0.3123	0.3205	0.1981	0.3679	−0.0169	0.2114	1.0000

The correlation coefficient	*Informal Size*	*GDPPC,PPP (constant 2005 international $)*	*HDI value*	*Infrastructure index*
Informal Size	1			
GDPPC,PPP (constant 2005 international $)	−0.2565***	1		
HDI value	−0.5722***	0.1361***	1	
Infrastructure index	−0.4062***	0.1552***	0.2808***	1

Note: ***Significant at 5% level of significance

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