Information technologies and entrepreneurship

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ABSTRACT

This article shows how the increase of information availability due to new technologies positively affects aggregate entrepreneurship in national economies. We rely on an "occupational choice" model of managerial production, extended to include the managerial use of information, to explain variations in the number of entrepreneurs, and thus of firms, as measured by the aggregate new business creation data. We present evidence that supports such a theory of industrial organization dynamics for a sample of 78 economies over the period 2004–2012 using panel data instrumental variable regressions.

Keywords: Entrepreneurship; Information and communication technologies; Managerial information; Industrial organization.
JEL classifications: D20, L26, M13, O57

1 INTRODUCTION

The aggregate levels of entrepreneurship, as measured by the World Bank's "new business density" data (the number of new limited liability corporations registered in the calendar year per 1,000 people aged 15–64), differ widely among nations and are changing over time. During the years 2010–2014 they reached only 0.5% in Argentina but 5.7% in Chile and 1.3% in

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Germany versus 11% in the United Kingdom. The complete set of available data[1] for the period 2000–2014, exhibits a mean value of 3.65 and a variance of 6.40, with a few extreme values ranging from zero to the highest levels of 15, 25 and even 58.3. It also shows that the sample average rates of entrepreneurship have been consistently rising over time during the successive subperiods 2000–2004, 2005–2009 and 2010–2014. What can explain that variance of entrepreneurship aggregate levels among countries and through time?

Potential entrepreneurs' psychological and sociological characteristics, rather stable in the short run, may explain cross-country differences, but not short-run variations. Countries' economic, legal and social institutions are also put forward in the literature as potential determinants (Van Praag & Van Ophem, 1995; Wennekers et al., 2005). However, their list is large, often lacks an explicit theory of the individual decision to become an entrepreneur, and the understanding of the underlying mechanisms remains incomplete (Stenholm et al., 2013). In an economic theory perspective, the determinants of the individual choice to become an entrepreneur should be specified in order to explain the aggregate result of these individual choices and thus provide a rational microeconomic foundation for macroeconomic results.

In this article we present the existing "information-augmented" theory of management of the firm[2] as an occupational choice tool for explaining the density of entrepreneurship at the macro level, and we test its validity on the World Bank's "new business density" dataseries. The rationale for the use of this theory of managerial activity to explain entrepreneurship is that entrepreneurs must be managers of the firms they create as they try to reap, through a specific organization of production and sales, the profit opportunities that they created or discovered in the price structure of inputs and outputs. We thus propose an original and simple formulation of the theory of entrepreneurship. It is new first in applying the "information-augmented theory of management" in the firm to the choice of the entrepreneur, and second in testing it on data regarding the change in aggregate entrepreneurship.

In the next section, we recap the classical definition of the entrepreneur and explain why he must become the manager of the firm he creates. The entrepreneur belongs to a sub-class of the wider category of managers, the latter including many managers that did not create the firm they manage. An entrepreneur is distinct from an employee-manager, as he owns the firm he created, and thereby bears the risk and rewards associated with it. As a consequence, his choice

[1] Data are retrieved from the World Bank entrepreneurship survey database, available at www.doingbusiness.org. The list of countries included in the dataset is presented in the appendix.

[2] As developed in Rosa (2000, 2006a, 2006b, 2018).

is to become an entrepreneur-manager, rather than a subordinate wage earner, or "employee".[3] This theory of the individual choice between a managerial and a subordinate position was first developed by Lucas (1978) in a general equilibrium model of occupational choice as a determinant of the size distribution of firms. To compare the productivities of the two types of occupation, and thus their respective rewards, Lucas introduces a production function of managerial services that impacts in a multiplicative way the traditional "engineering" production function that links capital and labor inputs to the outputs of the firm.[4]

Lucas views the production of managerial services, however, as determined by a single factor – the "talent" (or human capital) of the would-be entrepreneur-manager – and avoids being more specific about what entrepreneur-managers do. When considering the hierarchical nature of the firm and the role of the manager as the top decision-maker in that hierarchy, Rosa (2000, 2006a, 2006b, 2018) has shown that the quantity (or cost) of available information necessary for the manager to make decisions has to be added as a second factor (or input) in the production of management function. The implications of this model for firm size and entrepreneurship are then quite different from those of Lucas, whose model becomes a special case of the "information-augmented" general theory.

In the third section we develop formally the extended managerial occupational choice model incorporating the availability, or price, of information. The fourth section describes the data and the empirical methodology based on panel data instrumental variable regressions on a sample of 78 countries over the period 2004–2012. The fifth section presents the results, and the last section concludes and discusses the main findings, with implications for theory, policy making and future research.

2 THE ENTREPRENEUR-AS-MANAGER THEORY

Entrepreneurs try to discover price differences – profit opportunities – between bundles of inputs and bundles of outputs. Or they can create such opportunities. These discovery and

[3] The labor contract defines the employee's position as a subordinate to his immediate superior in the firm's hierarchy and ultimately to the top manager. We use the term *employee* rather than *worker* for subordinates because we assume that middle and top managers are also doing some useful and productive work. Thus, the alternative is not between being a worker and being something else, but between being an entrepreneur-manager and being an employee, that is, a subordinate.

[4] This gives back a central role to the manager in the analysis of the firm since, in his absence (and thus of any managerial services), the output of the firm is nil. Inversely, the higher his productivity, the larger the firm's output and profit.

creation processes are price-search activities, that can take place on the output side of production, on the input side or on both simultaneously.

As seekers of price differentials, entrepreneurs are "speculators", as Cantillon (1755/1931) defined them, looking for such arbitrage possibilities that could be carried out by launching a new production process – a firm. This creation of a new production team is necessary because one cannot sell a business idea (a very specific information about potential price differences) to anyone else – whether an existing firm, a "de novo" capitalist or another would-be entrepreneur – without giving away at the same time that very information "for free" in order to persuade a buyer of its potential viability. On the contrary, in building a new organization, an entrepreneur will keep at least some critical elements of his "recipe" to himself by breaking down the production process into many pieces, specialized tasks and jobs in which various specialists have no real view of the overall process (Rosa 2000, 2006a, pp. 219–225). Indeed, the entrepreneur must keep to himself the overall view of the process and thus the basic information that is the very foundation of his business. Entrepreneur-managers actively seek information in the various domains of activity of the firm: marketing, finance, engineering, labor relations. Obtaining that information is costly but at the same time required for profit maximization. The entrepreneur-manager is, to the subordinates working for his firm, what the "chef d'orchestre" is to the specialized musicians in the classical orchestra organization. No single collaborator is completely informed of the working of the whole value chain, and each one has to pledge to conform to confidentiality rules regarding his work for the firm. It follows that the creation of a new firm and its management cannot be dissociated at this stage.

This organizational and informational choice entails three consequences: First on the nature of managing, because the entrepreneur-manager must be the coordinator of a number of different specialists. He is, accordingly, a "jack of all trades" as Lazear (2004) puts it. Second because it follows that his human capital or talent is different from that of a specialist working under his direction. He is not as knowledgeable as his top collaborator in each specialized field, but more efficient in coordinating all of them. It can be, then, that one of his subordinates has a higher talent than his own, measured by return on human capital in a specialized "niche" of the labor market, and depending on the specific equilibrium of demand and supply for that qualification. For instance, a CFO or a trader could earn more than his CEO. But in case he would try to launch a new firm, this ex trader, now a new CEO, would not earn as much as he did previously. Third, since the foundational idea of the new firm cannot be sold in advance and should be kept confidential or "private", the entrepreneur has to be his own manager.

It follows that at the beginning of the firm, the entrepreneur must be a manager, and his occupational choice can be analyzed aptly within the managerial occupational choice framework. Hence the theory of the entrepreneurial choice (whether or not to create a new firm) is the same as the theory of choosing to become a new manager, but distinct from employee-managers, and belonging to a special class of the population of managers. This equivalence defines an "entrepreneur-as-manager" theory, since the occupational choice theory of the manager also explains the occupational choice of the entrepreneur. Moreover, for the same reason that the entrepreneur cannot sell his business idea – his discovery or creation of a profit opportunity in price differences – to another would-be entrepreneur, he cannot sell it either to a capitalist, because he would have to give away that information to obtain outside financing and would not be paid for it. It follows that the entrepreneur has to commit his own funds to finance the venture, and thus keep the profits, the residual income that rewards the capital, for himself, as long as he does not open the capital to outside investors. Hence his incentive to create a new firm is directly linked to the profit-wage ratio, that is, the ratio of rewards in his alternative occupations.

Every activity in an economy is risky, but investing in a business is more risky, due to the residual nature of profits and the absence of an upper limit to these profits while the lower bound is the total loss of invested capital, than the income from wages. The standard deviation of returns on capital is wider than the possible variation in wage payments (including the possibility of a zero wage as a lower limit in the case of unemployment after a business failure or a lay-off). In financial general equilibrium theories, the average expected return on risky assets is positively correlated to the amount of risk of those assets, as exemplified in the Capital Asset Pricing Models (CAPM).

In our model, the main determinant of the new firm creation is the ratio of profits to wages. Both profits and wages are fluctuating so that risk is indeed present in this ratio, at the core of the model. More entrepreneurs decide to create a firm when the ratio of profits to wages increases, which implies that they accept the risk that comes with the higher expected profits. They can only reap the higher profits they seek by accepting the inconvenience of higher risk-taking. Entrepreneurs also take a labor-market risk, as their own employees do too. It is linked in their case to their search for profits, as owner-employee, and is correlated with their acceptance of the higher risk on their capital investment in a new and small firm that is more prone to failure than large, established ones.

The two variables that drive our model, the growth rate of the economy and the quantity of available information, operate through their impact on the profit/wages ratio which measures

precisely at the macro level the differential return and the differential on risk-taking on respectively the capital investment in a new firm and on labor income as an employee. This ratio is a macro measure of the price (or reward) of risk-taking. Changes in the growth rate of the economy and in information availability directly affect the price of risk-taking, the differential return that can be earned on capital investment over labor supply in an employment contract. All this is included but kept implicit in the model because an exogenous change in risk-taking is not the cause of changes in entrepreneurship that we are looking for. Risk aversion is a characteristic of utility functions, which are stable or unchanged, at least in the short term, and thus cannot explain the changes in entrepreneurship behavior. The causes of changes in entrepreneurship, in our model, are the changes in the growth rate of the economy and in the quantity of available information. The changes in the price of risk, the profit/wages ratio that explains the changes in risk-taking, are endogenous in that framework.

The emphasis on growth and information reflects the fact that entrepreneurs look for profits, and profits result from differences between the price of outputs and the prices of inputs. Entrepreneurs thus look for maximal price differences between potential bundles of inputs and potential bundles of outputs. Given the huge number of prices of inputs and of outputs in an economy, entrepreneurs must do extensive search on several markets in order to maximize profits, because information is scarce. This search process as formalized in a neoclassical framework by Stigler (1961) and others, is the modern version of the "discovery process" of the Austrian school, thus made operational. In a context of information asymmetry, an entrepreneur can discover the opportunity to create a new venture, or he can create that opportunity, through an uncertain process (Alvarez and Barney, 2007; Alvarez, Barney and Anderson, 2013). In both circumstances, the entrepreneur must be a price searcher and search for all the managerial information needed in order to create and develop the new venture, and maximize the profits. In that capacity of information searchers, entrepreneur-managers cannot be replaced while in their capacity of owner-capitalists they can be, at a further stage of development of their firm. Specialized risk bearers – shareholders and fund managers – that allocate capital among already established and more mature, and thus likely to be more viable firms, decide to buy a share of the capital initially invested by the entrepreneur. These investors can also intervene at an earlier stage of the firm life-cycle as "venture capitalists" and "business angels" to buy the new firms that entrepreneurs have recently created if these entrepreneurs decide to exit as capital owners. It follows that many allocations of capital at risk from diverse investors are compatible with the optimal level of entrepreneurship previously defined in the present model, in which the number and sizes of firms have been determined.

2.1 The Lucas theory

In Lucas's theory, an individual chooses to become a new entrepreneur-manager rather than an employee when the profit-wage ratio is high enough above a cutoff rate. The profit level of an individual firm depends on the "talent" of the entrepreneur-manager in combining a given mix of capital and labor. More-talented entrepreneur-managers can also attract and pay more for capital and labor, and thus come to manage larger firms (as shown by Rosen, 1982). But the distribution of managerial talent in the population can be considered stationary in the short run so that the dynamics of the industrial organization must come from another source: as far as aggregate economic growth is a result of capital accumulation, the rate of return on capital – the profit rate – will fall with growth while the wage level increases with growth. Therefore, the profit-wage ratio falls with growth and, therefore, the incentive to become an entrepreneur falls with economic development, thus reducing the number of new entrepreneur-managers and new business creations. In the Lucas model, the number of firms thus falls with the growth of income per capita, and their average size thus rises. There is, then, a monotonous evolution of industrial organization towards higher concentration during development.

This implication of the model, however, has been shown to be counterfactual in the last few decades of the past century. The empirical tests that vindicated Lucas's analysis of data available up to 1978 have been later contradicted by recent evolutions. The number of firms has increased whereas their size shrank (Baldwin et al., 2002; Monnikhof & van Ark, 1996; Rosa & Hanoteau, 2012; Wennekers, 2006; White, 1981, 2002). Some more theorizing is thus required.

2.2 The information-augmented theory of the entrepreneur-manager

Capitalizing on his previous theory of the impact of information availability and cost on the equilibrium of the firm and industrial organization, and explaining why hierarchies develop when information becomes more scarce, Rosa (2000, 2006a) has developed an extended, information-augmented Lucas model of occupational choice, and thus of the average size of firms in an economy (Rosa, 2006b, 2018). This requires specifying what managers do. As top decision-makers in the hierarchical organization of the firm, the job of managers (and

entrepreneurs) is to make decisions in many fields, such as production, finance, human resources, marketing and so on. To do that they require information about various markets and environments. Better decisions requiring better information, it follows that for a given talent of the entrepreneur-manager, more information increases managerial productivity and profits.[5]

The Lucas production of management function $F = F(a_k)$, in which a_k is the managerial talent or human capital, has to be expanded to include the quantity of information I that the entrepreneur-manager uses. Then, $F = F(a_k, I)$.

In this modified framework, a growing abundance (and falling cost) of information in the economy leads to higher managerial efficiency for all entrepreneur-managers, higher profits, thus higher profit-wage ratios and a higher incentive to create new firms. The number of entrepreneurs and firms is increased, resulting in a fall of the average firm size. The dynamics of industrial organization is the exact opposite of that in the Lucas model.

As a consequence, this augmented theory can account for upsizing and downsizing trends in industrial organization and entrepreneurship and for possible reversal of these trends. The theory is thus quite general and has a broad range of explicative value.

It is apparent in the analysis of two major real-world phenomena regarding industrial organization: First, the importance of micro-entrepreneurship and self-employment, which is often defined as "necessity" entrepreneurship due to a lack of regular employment opportunities for less-qualified people in established large firms. Necessity entrepreneurship exists in developing as well as in developed countries, as documented by as Bjørnskov and Foss (2009). Second, the recent expansion of very large, global firms and the resulting increase in the concentration ratios of businesses – for instance, in the US (White & Yang, 2017) – reverting the previous downsizing trend (White, 1981, 2002). Both phenomena can indeed find a natural explanation in the framework of the augmented model.

Micro-entrepreneurship, self-employment and other "informal" enterprises are widespread, and this has spurred a vast literature that contrasts two basic types of entrepreneurs according to whether they are opportunity- or necessity-driven (Reynolds et al., 2003). Opportunity entrepreneurs "perceive a business opportunity and elect to start a business as one of several

[5] In a survey of the entrepreneurship literature, Fiet 1996 links the discovery of profit opportunities to the acquisition of risk-reducing private information.

possible career options" (Reynolds et al., 2003, p. 16), which is precisely the occupational choice framework of our model. Necessity entrepreneurs, however, are viewed as being compelled to start their own business as a livelihood instrument, because salaried employment, being either absent or unsatisfactorily paid, is not really an option for them. But saying this is equivalent to saying that the potential wage these fringe job seekers can obtain in established firms is either zero or in any case below what they can earn in their own micro or informal firm. This could in particular be the case of refugees or illegal immigrants, or of other low productivity prospective employees (for instance because they are illiterate). Where the cost of labor is high, due to taxes and regulations weighing on legal employment, micro-entrepreneurs operate in the informal sector in order to avoid these costs and bring down extra labor costs to the low productivity level of unqualified labor, thus allowing these workers to get an income they cannot find in the legal sector. The size of the informal economy can be substantial in developing as well as in developed countries (Medina and Schneider, 2018). In such cases, micro or informal entrepreneurship, because it reduces the cost of operating a firm by avoiding costly regulations, taxes, and accepting low profits, is the only realistic possibility for earning one's living. It is nevertheless a part of the occupational choice model as a corner solution in our analytical framework.

Moreover, the dynamics of the Lucas model, which is still valid in the expanded model, implies that the lower the income per capita (and wages), the lower the size of firms and thus the larger their number, because the profit/wage ratio is high due to the scarcity of capital relative to labor. "Necessity" – that is, "micro" or "informal" – entrepreneurship, is thus accounted for in our general framework and does not require a specific, ad hoc, theorizing.

Another question raised by recent evolutions since the turn of the century is that of the huge expansion of global firms and the reconcentration trend that can be observed in the US while the growth of information availability continues unabated. This does not invalidate Rosa and Hanoteau (2012) analysis of the downsizing effect of the information revolution on theoretical grounds, because of the existence, again, of the income effect (Lucas, 1978).

In claiming that when the cost of information is high, firms should be large, and when it becomes cheaper, firms can become smaller, it is assumed that the income level per capita is unchanged (the "all things being equal" condition). This conclusion is conditional on other determinants of the number of firms, and thus firm size, being held constant. In Lucas's model, the accumulation of capital during development increases the wage level and decreases the profit level. It follows that the incentives to become an entrepreneur-manager is weakened when

growth occurs as a result of capital accumulation, and therefore the new firm creation decreases with the development of the economy, while the average size increases.

The recent spectacular expansion of markets worldwide following international trade liberalization and the vanishing of command economies (USSR, Chinese central planning) has determined a rapid growth of the world markets that also has led to accelerated GDP growth and rapidly rising income per capita. Accordingly, entrepreneurship has been slowing down and large firms have become larger, as is the case with large international firms such as Apple, Google and Amazon, for instance (Rosa, 2018).

Having defined and explained the role of the entrepreneur as manager on the one hand, but also as capitalist – because he cannot persuade external capitalists to invest in his project without giving away the profitable information that he has gathered at a cost – we can understand that the entrepreneur's income may come from wage and profits. This is because he is both a wage earner as manager, and a venture capitalist deriving additional income from profits.[6] Later in the firm's life cycle, the entrepreneur can choose to quit as capitalist by selling his share of the capital, or even quit as manager while conserving his shares. In the latter case, the newly recruited head of the firm is defined as a manager and not as an entrepreneur.

Having summarily presented an informational theory of the entrepreneur, in the next section, we develop an analytical formulation of the information-augmented occupational choice theory of entrepreneurship.

3 THE FORMAL MODEL

There are *N* individuals in the population, and they can be either employees or entrepreneurs.[7] Each individual has an ability level a that is constant over time. The ability levels are distributed, exogenously, among the population according to a distribution function $G(a)$ with continuous density $g(a)$ and defined based on the interval (domain of integration) $S \subset \mathbb{R}_+$. The distribution function does not change over time.

[6] The reason why the entrepreneur can pay wage to himself rather than being paid only by a share of profits has something to do with the residual character of profit and the priority of wages. It is also explained by the many advantages (for instance, Social Security and other benefits) that a wage-earner status carries with it that the status of capital owner does not bring in by itself. But the frontier between wage payment and profits is blurred when managers are also routinely compensated by variable bonuses linked to profit levels.

[7] Our formulation follows Bajona and Locay's (2009) simplified version of Lucas's (1978) model.

3.1 The managerial output function

Entrepreneurs produce a managerial output that is the outcome of a management function, $(a, I_t) = F\left(a^{\beta}, I_t^{1-\beta}\right)$, with the parameter β such that $0 \leq \beta \leq 1$. It is a function of the talent a and a quantity of information I_t that is necessary for managing the firm and its various operations. This information is costly, with a cost z_t that depends on the cost of information storage and information communication technology (ICT). The development of the internet, fixed and mobile telephone technologies, infrastructures and cheaper access foster the diffusion of all the information that entrepreneurs need, thus increasing the total quantity of information available and reducing its costs.

Given the ability level of the entrepreneur and the quantity of information he uses, a firm produces an output $y(a, I_t)$ according to the following relation:

$$y_t(a, I_t) = \lambda_t\left(a^{\beta} I^{1-\beta}\right)^{1-\theta} H_t^{\theta} \quad (1)$$

The first bracketed term is the "managerial technology" or the "managerial production function", and the second term is the "production technology" or "traditional 'entrepreneur-less' production function". For ease of presentation, this latter function admits only one production factor, H_t, which is the number of employees paid at a wage w_t, with $\beta, \theta \in [0; 1]$. λ_t is a technology factor. Because we model the production of managerial output as a function of information gathered, in addition to the individual's ability level, the occupational choice now directly depends on the cost of information in the economy, thus on the cost and availability of technologies of information production and exchange (ICT).

3.2 The optimal entrepreneurship solution

The optimal number of entrepreneurs is given by the entry of entrepreneurs, which is determined at the margin when the profit earned by an entrepreneur is just equal to his opportunity cost, that is, the wage the entrepreneur can earn in a salaried position. We define the threshold $\tilde{a_t}$ as the ability level of an individual indifferent between entrepreneurship and becoming an employee:

$$\pi(\tilde{a}_t, z_t) = w_t \quad (2)$$

People with abilities higher than $\widetilde{a_t}$ become entrepreneurs, and otherwise they choose to be employees. The output price is normalized to one, and input prices are relative prices. The potential entrepreneur considers the maximum profit of the firm such that[8]

$$\pi_t(a) = \max_{H_t, I_t} \left\{ \lambda_t \left(a^{\beta} I^{1-\beta} \right)^{1-\theta} H_t^{\theta} - z_t I_t - w_t H_t \right\} \tag{3}$$

From the first-order conditions, we obtain the labor-information ratio adopted by an entrepreneur of ability *a*, such that

$$\frac{H_t}{I_t} = \frac{\theta}{(1-\theta)(1-\beta)} \frac{z_t}{w_t} \tag{4}$$

Note that this input ratio does not depend on ability *a* but only on the relative prices of inputs, just as in Lucas (1978). This means that during each given period, entrepreneurs use the same ratios of inputs. From here, we obtain the entrepreneur's demand for factors in equilibrium:

$$I_t(a) = a \lambda_t^{\frac{1}{\beta(1-\theta)}} \ \Delta_t \tag{5}$$

$$H(a) = a \lambda_t^{\frac{1}{\beta(1-\theta)}} \Delta_t \frac{\theta}{w} \frac{z}{(1-\theta)(1-\beta)} \tag{6}$$

With $\Delta_t = \left[\frac{z}{(1-\theta)(1-\beta)} \right]^{-1/\beta} \left[\frac{w}{\theta} \right]^{\frac{\theta}{\beta(\theta-1)}}$

Note that from (5), we have $\frac{\partial I(a)}{\partial z_t} < 0$, and a higher cost reduces the use of information. We can then derive the equilibrium levels of output and profit for an entrepreneur with an ability level *a*:

$$y_t(a, z_t) = a \left(\Delta_t \lambda_t^{\frac{1}{\beta(1-\theta)}} \right)^{1-\beta+\beta\theta} \left(\frac{\theta}{w} \frac{z_t}{(1-\beta)(1-\theta)} \right)^{\theta} \tag{7}$$

$$\pi(a, z_t) = \left[1 - \lambda_t \left((1-\beta)(1-\theta) + \frac{\theta}{w} \right) \right] y_t(a, z_t) \tag{8}$$

Each individual chooses the most rewarding activity, and this depends on his own private ability *a*. An individual with the threshold level of talent $\widetilde{a_t}$ is just indifferent between the two activities because they offer the same rewards as written in equation (2).

[8] The model is simplified assuming no tax. Introducing labor and/or profit taxes would not change the results.

Given that profit is an increasing function of ability level *a*, at each period, all individuals with an ability superior to $\widetilde{a_t}$ decide to be entrepreneurs, and all individuals with ability levels below $\widetilde{a_t}$ become production workers.

Using (7) and (8) in (2), we obtain the threshold value:

$$\widetilde{a_t} = \frac{w_t}{\left[1-\lambda_t\left((1-\beta)(1-\theta)+\frac{\theta}{w}\right)\right]}\left[\lambda_t\right]^{-\frac{1}{\beta(1-\theta)}}\left(\frac{z_t}{(1-\beta)(1-\theta)}\right)^{\frac{1}{\beta}-1}\left(\frac{w}{\theta}\right)^{\frac{\theta}{\beta(1-\theta)}} \quad (9)$$

We can see from (9), that $\frac{\partial \widetilde{a_t}}{\partial z_t} \geq 0$, whenever $w_t \geq \frac{\lambda\theta}{1-\lambda(1-\beta)(1-\theta)}$. This condition is always satisfied if we assume that $\lambda \geq \frac{1}{(1-\beta)(1-\theta)}$. This means that $\widetilde{a_t}$ is increasing in z_t when the opportunity cost (wage of employees) of being an entrepreneur is high enough.[9]

A drop in the price of ICT (or, equivalently, a higher volume of ICT), reducing the cost of information, raises firms' profit, and, therefore, the managerial productivity of all existing and potential entrepreneur-managers, everything else being constant. This induces additional wage earners with lower ability levels to become entrepreneurs, and this raises the aggregate level of entrepreneurship in the economy.

4 DATA AND ECONOMETRIC METHODOLOGY

We test on an unbalanced panel of 78 countries (see the appendix) with annual observations over the period 2004–2012, the validity of the following reduced form of the model:

$$y_{i,t} = a + bx_{i,t} + cZ_{i,t} + T_t + C_i + \mu_{i,t}, \quad (10)$$

where $y_{i,t}$ stands for the level of entrepreneurship in country *i* during the period *t*, and $x_{i,t}$ is the measure of ICT price (or quantity) and is considered a proxy measure for the price (or quantity) of information. *Z* is a vector of other variables that could influence the decisions of wage earners to become entrepreneurs through their impact on the central determinant of the occupational choice model, that is, the profit-wage ratio. A time trend $\underline{T_t}$ is added to measure and control for the possible influence, common to all countries in the sample, of drifting cultural or political

[9] Extremely low monetary wages are prevalent in the informal sectors of underdeveloped "dual economies", where micro-entrepreneurship is usually not registered and is an alternative to unemployment and a complement to precarious salaried work (Vial & Hanoteau, 2015).

factors not specified in the model that could also follow a strong time trend pattern. The parameter C_i stands for a country fixed effect. The panel structure of our dataset enables us to account for heterogeneity across countries. There may remain some unobservable country characteristics likely to affect the level of new business creation. If not taken into account, they may create a bias in the empirical analysis. Such unobserved effects can be, in some countries, a significant population of refugees and immigrants, with a poor access to the job market, and thus compelled by necessity, to start their own micro-business or become self-employed. We use a fixed effect estimation so as to treat such unobserved effects. It is more appropriate than a random effects estimation; as in our case of a fixed number of countries, the inferences are based only on this set (Wooldridge 2002). $\mu_{i,t}$ is the error term.

4.1 Data and variables

We measure new business formation at the country level, with the *New business density* data originating from the World Bank Group Entrepreneurship Survey (WBGES). As a proxy for the availability of information, we use price and quantity measures of ICT, taken from the International Telecom Union (ITU, 2009, 2010, 2012, and 2013). Our choice of using six alternative measures of ICT price and equipment is justified by the robustness of the analysis and also accounts for the fact that the information society relies on a networked and digital infrastructure that has several components. Considering a single ICT would not account adequately for the level of digital development (information society) within a country (Billon et al., 2009).

To measures the quantity of ICT, we use the numbers of *Fixed telephone subscriptions*, *Mobile phone subscriptions* and *Internet fixed broadband subscribers*, all expressed per 100 inhabitants (ITU). These three variables are considered between 2004 and 2012 for 78 countries and lead us to perform a first series of regressions on a sample of 618 year-country observations.

Second, we consider three country-level prices of ICT: *Fixed telephone price*, which is the price of a three-minute local call using fixed telephone lines; *Mobile phone price*, the price of a standard package for mobile phone monthly use (30 outgoing calls per month and 100 SMS) and *Internet fixed broadband price*, the price of an entry-level internet fixed broadband subscription plan. ITU converts these price data into current dollars using the World Bank Atlas

method, which aims to smooth fluctuations in exchange rates and differences in inflation rates.[10] The price variables are taken from 2008 to 2012, leading us to conduct a second series of regressions on a sample of 340 year-country observations.

The tested relation is likely to suffer from endogeneity because new business creation in the ICT sector may explain the diffusion of ICTs and/or their decreasing prices, especially because entry appears dynamic in that sector. Indeed, Brandt (2004), Bartelsman et al. (2005) and Hathaway (2013) observe for European Union, the US and the OECD that entry rates were significantly higher in the ICT sector than in the whole private economy, even compared to high-tech sectors.[11]

The presence of endogeneity is confirmed by a Durbin-Wu-Hausman test, with results presented at the bottom of Tables 2a and 3a. In order to treat endogeneity, we use instrumental variables for the ICT price and quantity variables. We take indicators of competition, regulatory reform and infrastructures in the ICT sector as excluded instruments. Competition and regulatory reforms in the telecom sectors influence ICT prices and diffusion (Buys et al., 2009; Howard & Mazaheri, 2009; Kiiski & Pohjola, 2002). This influence is direct, for example, with competition in the mobile phone sector affecting the penetration of mobile phones (Rouvinen, 2006). It is also indirect, due to substitution effects, for example, with wireless telephony, which has increasingly replaced wire lines (Rouvinen, 2006), and mobile phones, which are more and more used to access the internet in developing countries, enabling a cheaper connectivity compared to fixed internet connections (Howard & Mazaheri, 2009). ICT infrastructures are identified as key factors explaining lower ICT prices (Billon et al., 2009). This leads us to select, as excluded instruments, six variables related to competition, regulatory reform and infrastructures in the ICT sector. We use an indicator *Fixed telephone liberalization* (binary variable) of the liberalization of the consumer market for fixed communication services (Howard & Mazaheri, 2009) and define as the presence of multiple service providers in long-distance telephony. We use a variable that counts the number of years elapsed since the privatization of the state-owned telecommunication provider (first sale of a majority stake in the relevant state-owned telecommunication company), and we label it *Years of privatization*.[12]

[10] More details on this Atlas conversion method can be found at http://data.worldbank.org/indicator/NY.GNP.PCAP.CD .

[11] The authors' own calculations, using Eurostat data on business demography (retrieved from http://ec.europa.eu/eurostat/web/structural-business-statistics/data/database), evidence similar patterns for European countries for the period 2009–2012.

[12] These definitions and data for the period 2004–2007 come from Howard and Mazaheri (2009). Additional data for the period 2008–2012 were collected by, and are available from, the authors.

A third excluded instrument is a binary variable *Mobile sector competition,* with competition defined as the presence, a given year, of at least three mobile phone service providers (mobile operators) in the country (Gruber & Verboven, 2001). Data originate from the GSM Association and were completed by the authors collecting information from national telecom regulation agencies and mobile operators. In addition, we created a variable that counts the number of years elapsed since this competition had been in effect and label it *Years of mobile sector competition***.** Following Billon et al. (2009), we use the number of *Secure internet servers* per million people as an indicator of ICT infrastructures. Data are retrieved from the World Bank Development Indicators (WBDI) database. In addition, we use an interaction term between these excluded instruments and a control variable that Nichols (2007) suggests as a valid procedure for adding excluded instruments and is often better than looking for additional or weak ones.

4.2 Other influences on occupational choices

One can find, in the empirical literature, several variables other than information that are deemed to influence the aggregate level of entrepreneurship, such as access to financial resources (Evans & Jovanovic, 1989), the domestic growth rate, starting business regulations, the presence of foreign firms, as well as educational levels (Acs et al., 2008; Bowen & De Clercq, 2008; Van Stel et al., 2007; Wennekers et al., 2005). The growth of income is already included as the dynamic determinant of the change in the number of firms by Lucas, because it is in our model. Regarding other complementary influences, such as regulations or the presence of foreign competitors, we agree that they can affect profit levels and thus the basic determinant of new managers' entry into the economy. Education, however, magnifies the managerial efficiency in the use of information and, consequently, can also affect profits. Accordingly, we include these variables, alongside the information cost and availability, in our empirical regressions.

So as to account for the ease of access to financial resources, we use domestic credit to the private sector as a share of GDP. This encompasses loans, purchases of nonequity securities, trade credits and other accounts receivable. Data originate from the WBDI, and we label the variable *Credit.* To measure domestic *GDP growth rate,* we take the GDP per capita growth rate (Van Stel et al., 2007) from the WBDI. *Starting business regulations* is measured as the number of procedures necessary to create a firm and originates from the World Bank Doing

Business (WBDB) database. We account for the *Foreign firms presence* using the stock of inward foreign direct investment as a percentage of GDP (Bowen & De Clercq, 2008). Data are from UNCTAD (www.unctad.org). We take the primary school gross enrolment ratio, which is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown (WBDI). We label this variable *Education 1st.*

Table 1 presents the descriptive statistics and matrixes of correlations for the variables used in the two series of tests. The excluded instruments (variables numbered 10, 11 and 12 in the upper part of Table 1 and variables 10 and 11 in the lower part) are not or are weakly correlated with *New business density*, indicating that they are not strongly associated and that the orthogonality condition is satisfied. To confirm this, we conduct a series of identification tests.

[Insert Table 1 here]

5 RESULTS

We estimate the relation in (10) using panel fixed effect instrumental variable regression for the alternative ICT quantity and price variables. The first three columns of Tables 2a and 3a present the second stage results of the main regressions, showing that quantity variables – *Fixed telephone subscriptions* and *Internet fixed broadband subscribers* – have a positive and significant effects on *New business density.* It is also positive in the case of *Mobile phone subscriptions,* but only at 13.8% of confidence. Estimates for the price variables *Fixed telephone price* and *Internet fixed broadband price* exert a negative significant effect. The estimated parameter for *Mobile phone price* is also negative, but not significant.

The estimated parameters (Table 2a) mean that a 1% increase in *Fixed telephone subscriptions* raises *New business density* by 0.196% annually on average over the period. For *Fixed broadband subscribers,* the increase is 0.53% and 0.015% for *Mobile phone subscriptions,* although weakly significant. Similarly, from the results of Table 3a, we see that a 1% decrease in the *Fixed telephone price* raises *New business density* by 0.093%, and a 1% decrease in the *Internet fixed broadband price* raises it by 0.057%.[13] For *Mobile phone price,* the figure is 0.15% but is not significant.

[13] Because ICT prices are in log, in order to interpret the estimated parameters β, we use the following transformation: $\Delta y=(\beta/100)\Delta x$. If we increase x by 1%, we expect y to increase by (β/100) units of y.

Tables 2b and 3b show the first stage results and a series of identification tests. The excluded instruments are generally significant, except *for Mobile phone price*, and for the regression on *Fixed telephone price*, *Mobile sector competition* is not significant and weakly significant at the 12.8% level for the regression on *Internet fixed broadband price.* The identification tests lead us to be confident about the validity of the selected excluded instruments and of the instrumental variable procedure. In particular, the Sargan statistics are nonsignificant (except for the regression on *Mobile phone subscriptions*), meaning that the orthogonality condition is satisfied (Wooldridge, 2002).

Because multicollinearity might be an issue (e.g., between education and the ICT main explanatory variables), we perform further regressions in which we remove successively some of the control variables. The results are presented on the columns 4 to 9 of Tables 2a, 2b and 3a and 3b and they remain roughly unchanged. Because outliers can be a problem, the Hadi (1992) multivariate outliers elimination method is used. It leads to cuts of about 3% in the number of observations. The results of regressions without outliers, not shown here, are robust.

[Insert Table 2a here]

[Insert Table 2b here]

[Insert Table 3a here]

[Insert Table 3b here]

6 CONCLUSION

While the massive reduction in computing and communication costs resulting from the "information revolution" has generated a substantial restructuring of the economy (Brynjolfsson & Hitt, 2000), the main focus of many economic studies has been centered on the search for a positive impact of new technologies on individual firms productivity. We emphasize instead the industrial organization consequences of the new availability of information, and especially the change in new business creation that it has induced, that is, in the number of entrepreneurs – the entrepreneur being defined as the creator of a new firm as in the classical writings of Cantillon and Say – an objective and easy-to-measure definition.

In that perspective, the change in the aggregate level of entrepreneurship is just the change in the number of new firms, hence, a change in industrial organization.

Capitalizing on Lucas's foundational general equilibrium occupational choice theory of industrial organization, we then use and test its extension by Rosa into a general, information-augmented, theory of managerial production in order to explain the successive and alternating trends towards concentration and deconcentration phases in the main developed economies during the past several decades. Using information as a factor of production in the managerial production function in that way, our results show that the price of information significantly and negatively affects the entrepreneur's efficiency whereas its quantity affects it positively, and thus, the new abundance and falling cost of information boosting expected profits, the number of entrepreneurs in the economy also rises. It follows that information must be seen as a central determinant in a theory of entrepreneurship, exerting a contrary influence to that of rising income per capita on the incentive to become an entrepreneur and thus on aggregate entrepreneurship.

These results also have policy implications, as they pave the way for future studies of the impact of investments in information technologies and infrastructure as well as of alternative entrepreneurship policies on the dynamism of the economy.

The Global Entrepreneurship Monitor suggests that information technologies explain a large portion of the worldwide increase in entrepreneurship (GEM, 2018). In this article, we offer an "industrial organization dynamics" explanation putting forward the role of ICTs that foster the access to managerial information. This work can also be considered from the perspective of the ongoing research on entrepreneurial ecosystems. Experienced entrepreneurs, through their successes and failures, accumulate specific expertizes and knowledge on how to grow their venture, market their products, pitch to investors, and hire and manage employees. These examples of managerial information are essential resources for would-be entrepreneurs, provided to them in particular through local entrepreneurial ecosystems (Spigel, 2017). The worldwide increase in entrepreneurship, resulting in more numerous entrepreneurs, thus favors the accumulation of managerial information, and the development of entrepreneurial ecosystems as well. Indeed, these latter are endogenous creations, initiated by entrepreneurs themselves, who are in the best position to identify the information and resources needed to create and nurture new ventures (Feld, 2012). Experienced entrepreneurs can share and spread their specific knowledge and expertizes (managerial information) through entrepreneurial ecosystems and this phenomenon is further enhanced by new information technologies that facilitate the organization of entrepreneurial networks and the circulation and sharing of information within them (Feld, 2012).

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Table 1 Descriptive statistics and correlation matrix

	Part A: Quantities of ICT	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
(1)	New business density	1											
(2)	Fixed telephone subscriptions	0.354*	1										
(3)	Mobile phone subscriptions	0.345*	0.532*	1									
(4)	Internet fixed broadband subscribers	0.312*	0.813*	0.602*	1								
(5)	Credit	0.402*	0.706*	0.478*	0.737*	1							
(6)	GDPpc growth rate	−0.035	−0.377*	−0.367*	−0.456*	−0.366*	1						
(7)	Foreign firm presence	0.529*	0.293*	0.349*	0.325*	0.307*	−0.047	1					
(8)	Starting business regulation	−0.428*	−0.465*	−0.413*	−0.559*	−0.469*	0.243*	−0.315*	1				
(9)	Education 1st	−0.133*	−0.228*	−0.247*	−0.252*	−0.205*	0.065	−0.133*	0.372*	1			
(10)	Years of privatization	0.136*	0.212*	0.182*	0.254*	0.230*	−0.088*	0.166*	−0.043	−0.109*	1		
(11)	Years of mobile sector competition	−0.024	0.319*	0.444*	0.526*	0.384*	−0.264*	0.059	−0.250*	−0.159*	0.283*	1	
(12)	Secure internet servers (per million people)	0.282*	0.558*	0.332*	0.752*	0.605*	−0.290*	0.156*	−0.425*	−0.141*	0.196*	0.401*	1
	Mean	3.547	0.272	0.883	0.109	0.774	0.037	0.464	8.186	1.045	9.617	7.359	248.92
	Standard deviation	4.496	0.191	0.404	0.114	0.558	0.038	0.584	3.497	0.079	9.658	4.916	486.88
	N	601	601	601	601	601	601	601	601	601	601	601	601
	Part B: Prices of ICT	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	
(1)	New business density	1											
(2)	Fixed telephone price (log)	0.242*	1										
(3)	Mobile phone price (log)	−0.003	0.650*	1									
(4)	Internet fixed broadband price (log)	−0.062	0.201*	0.168*	1								
(5)	Credit	0.379*	0.523*	0.335*	0.044	1							
(6)	GDPpc growth rate	−0.067	−0.342*	−0.165*	0.077	−0.378*	1						
(7)	Foreign firm presence	0.617*	0.148*	−0.071	−0.028	0.321*	−0.070	1					
(8)	Starting business regulation	−0.422*	−0.341*	−0.241*	−0.041	−0.444*	0.213*	−0.331*	1				
(9)	Education 1st	−0.164*	−0.189*	0.055	0.137*	−0.202*	0.194*	−0.155*	0.400*	1			
(10)	Mobile sector competition	−0.058	0.272*	0.165*	−0.308*	0.160*	−0.119*	0.076	−0.057	−0.239*	1		
(11)	Liberalization	0.051	0.283*	0.168*	−0.077	0.257*	−0.092	0.090	−0.156*	−0.218*	0.471*	1	
	Mean	0.004	4.986	5.037	5.739	0.810	0.023	0.496	7.783	1.046	0.904	0.871	
	Standard deviation	0.004	0.820	0.795	0.696	0.570	0.042	0.626	3.385	0.074	0.296	0.409	
	N	324	324	324	324	324	324	324	324	324	324	324	

** Signifiant at .01.*

Table 2a Panel data two stages least squares estimates – ICT quantities – Second stage results

Second stage results	New business density								
Explanatory variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
Fixed-telephone subscriptions	0.196***			0.151**			0.154**		
	(0.008)			(0.039)			(0.029)		
Mobile phone subscriptions		0.015			0.008			0.010	
		(0.138)			(0.434)			(0.348)	
Internet fixed-broadband subscribers			0.530**			0.557**			0.584**
			(0.017)			(0.013)			(0.015)
Credit	2.965***	2.685***	-0.0229	2.894***	2.679***	-0.172	2.905***	2.693***	-0.256
	(0.000)	(0.000)	(0.986)	(0.000)	(0.000)	(0.895)	(0.000)	(0.000)	(0.851)
GDPpc growth rate	7.002***	7.805***	16.24***	6.435***	7.210***	16.13***	6.398***	7.126***	16.45***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Starting business regulation	-0.0101	-0.0427	-0.151*	-0.019	-0.049	-0.158*			
	(0.859)	(0.417)	(0.097)	(0.747)	(0.376)	(0.093)			
Education 1st	5.182***	4.309**	2.004						
	(0.008)	(0.019)	(0.494)						
Foreign firms presence	2.419***	2.453***	1.712**						
	(0.000)	(0.000)	(0.011)						
Trend	0.0310	-0.153*	-0.677**	0.058	-0.057	-0.682**	0.064**	-0.057	-0.673**
	(0.421)	(0.068)	(0.013)	(0.129)	(0.510)	(0.016)	(0.045)	(0.514)	(0.019)
Constant	-11.03***	-4.232**	0.858	-3.333	1.328*	3.655**	-3.638*	0.788*	2.058***
	(0.002)	(0.040)	(0.807)	(0.180)	(0.073)	(0.006)	(0.090)	(0.055)	(0.003)
Observations	601	601	601	601	601	601	601	601	601

Notes: P-values in parentheses. *, **, *** mean significant at 10%, 5% and 1% levels.

Table 2b Panel data two stages least squares estimates – ICT quantities – First stage results

First stage results.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Excluded instruments									
Years of privatization	0.002			0.002*			0.002*		
	(0.144)			(0.078)			(0.070)		
Years of mobile sector competition		-0.017**	0.005***		-0.016**	0.005***		-0.016*	0.004***
		(0.025)	(0.001)		(0.033)	(0.001)		(0.036)	(0.002)
Secure Internet servers (per million people)	-0.00003***	-0.0002***		-0.00003***	-0.0002***		-0.00003***	-0.0002***	
	(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)	
Secure Internet servers * GDP growth rate			0.0001			0.001			0.0001
			(0.548)			(0.542)			(0.548)
Kleibergen-Paap Wald *F*-statistic (weak identification test of the excluded instruments)	22.41	45.22	5.45	23.41	45.19	5.64	25.24	46.69	5.27
Anderson-Rubin Wald F-statistic (test of joint significance of endogenous regressors)	4.55	11.91	10.84	2.98	9.91	8.35	3.28	10.41	8.58
Sargan statistics (test of overidentifying restrictions)	0.930	20.61	0.510	1.386	18.712	0.438	1.380	19.309	0.394
	(0.334)	(0.000)	(0.475)	(0.239)	(0.000)	(0.508)	(0.240)	(0.000)	(0.530)
Anderson can. corr. *LM*-statistic (underidentification test)	41.87	7812	8.08	43.43	77.82	11.17	46.45	79.88	10.44
	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.038)	(0.000)	(0.000)	(0.005)
Haussman-Durbin-Wu test of endogeneity	(0.000)	(0.016)	(0.000)	(0.000)	(0.018)	(0.000)	(0.000)	(0.064)	(0.000)

Notes: P-values in parentheses. *, **, *** mean significant at 10%, 5% and 1% levels.

Table 3a Panel data two stages least squares estimates – ICT prices – Second stage results

Second stage results	New business density								
Explanatory variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
Fixed-telephone price (log)	-9.033*			-9.223*			-6.866*		
	(0.079)			(0.075)			(0.083)		
Mobile phone price (log)		-15.37			-14.83			-10.93	
		(0.353)			(0.318)			(0.275)	
Internet fixed-broadband price (log)			-5.676*			-5.742*			-5.571*
			(0.061)			(0.055)			(0.063)
Credit	2.429	9.131	2.954	2.857	8.286	3.179	3.126*	7.264	3.343*
	(0.237)	(0.320)	(0.171)	(0.153)	(0.254)	(0.121)	(0.065)	(0.174)	(0.092)
GDPpc growth rate	10.70**	55.83	10.87**	10.04**	53.09	10.16**	9.332**	40.93	9.941**
	(0.014)	(0.267)	(0.013)	(0.021)	(0.240)	(0.021)	(0.011)	(0.177)	(0.021)
Starting business regulation	-0.300*	-0.339	-0.0904	-0.315*	-0.433	-0.118			
	(0.090)	(0.371)	(0.559)	(0.073)	(0.289)	(0.438)			
Education 1st	-0.654	-22.31	-4.509						
	(0.917)	(0.410)	(0.504)						
Foreign firms presence	1.846	0.814	1.592						
	(0.268)	(0.834)	(0.355)						
Trend	-0.150	1.813	-0.447**	-0.110	1.797	-0.410**	0.00296	1.441	-0.355*
	(0.190)	(0.389)	(0.029)	(0.324)	(0.340)	(0.049)	(0.970)	(0.282)	(0.084)
Constant	50.09*	79.74	42.50*	50.67*	55.74	38.64**	35.13*	37.42	36.08*
	(0.068)	(0.339)	(0.054)	(0.057)	(0.289)	(0.037)	(0.071)	(0.256)	(0.054)
Observations	324	324	324	324	324	324	324	324	324

Notes: P-values in parentheses. *, **, *** mean significant at 10%, 5% and 1% levels.

Table 3b Panel data two stages least squares estimates – ICT prices – First stage results

First stage results.	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
Excluded instruments									
Fixed telephone liberalization	0.244*	0.132	0.367*	0.241*	0.135	0.365*	0.272**	0.177	0.331
	(0.059)	(0.485)	(0.089)	(0.061)	(0.477)	(0.090)	(0.029)	(0.334)	(0.110)
Mobile sector competition	0.115	0.098	0.251*	0.121	0.111	0.264*	0.113	0.101	0.272*
	(0.241)	(0.500)	(0.128)	(0.218)	(0.444)	(0.100)	(0.244)	(0.482)	(0.096)
Kleibergen-Paap Wald *F*-statistic (weak identification test of the excluded instruments)	2.46	0.47	2.60	2.50	0.54	2.72	3.02	0.69	2.59
Anderson-Rubin Wald F-statistic (test of joint significance of endogenous regressors)	7.29	7.29	7.29	7.64	7.64	7.64	7.31	7.31	7.31
Sargan statistics (test of overidentifying restrictions)	0.917	0.071	0.386	1.054	0.080	0.462	2.83	0.616	0.762
	(0.338)	(0.789)	(0.535)	(0.305)	(0.778)	(0.497)	(0.092)	(0.495)	(0.383)
Anderson can. corr. *LM*-statistic (underidentification test)	4.98	0.98	5.25	5.13	1.11	5.57	6.16	1.41	5.29
	(0.082)	(0.619)	(0.072)	(0.077)	(0.574)	(0.062)	(0.046)	(0.493)	(0.071)
Haussman-Durbin-Wu test of endogeneity	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: P-values in parentheses. *, **, *** mean significant at 10%, 5% and 1% levels.

Appendix: List of countries in the sample

Algeria	Estonia	Latvia	Serbia
Argentina	Ethiopia	Lithuania	Singapore
Australia	Finland	Macedonia	Slovak Republic
Austria	France	Malawi	Slovenia
Bangladesh	Germany	Malaysia	South Africa
Belgium	Ghana	Mexico	Spain
Bolivia	Guatemala	Morocco	Sweden
Bosnia & Herzegovina	Hong Kong	Netherlands	Switzerland
Botswana	Hungary	New Zealand	Syria
Brazil	Iceland	Nigeria	Thailand
Canada	India	Norway	Tonga Islands
Chile	Indonesia	Pakistan	Tunisia
Colombia	Ireland	Panama	Turkey
Costa Rica	Israel	Peru	Uganda
Croatia	Italy	Philippines	United Arab Emirates
Czech Republic	Jamaica	Poland	United Kingdom
Denmark	Japan	Portugal	Uruguay
Dominican Republic	Jordan	Romania	Vanuatu
Egypt	Kazakhstan	Russia	Zambia
El Salvador	Korea (South)		