CÁTEDRA TELEFÓNICA

POLÍTICA Y REGULACIÓN TELECOMUNICACIONES E INTERNET
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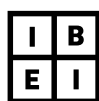
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The impact of ICTs on employment in Latin America: A call for comprehensive regulation

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Abstract

The purpose of this research is to determine the manner in which employment will evolve as a result of information and communication technologies. Prior research has shown that both communication and automation are displacing certain type of employment, mainly those with middle level skills. Given the evidence from countries with greater penetration of ICTs we expect Latin America to follow a similar path and potentially be negatively affected by the elimination of some professions. Researchers that have analyzed the impact of ICTs on employment have found that there has been a gradual move from agriculture, to manufacturing and to services with service economies being the latest iteration in development. The economic prospects for these service economies, however, will depend on the composition of the service professions. Ideally societies should aim to employ people in professions that require higher level skills as they would likely result in higher incomes and improved development prospects. ICTs are currently generating employment in the Latin American region and this is likely to remain the case for some years as these technologies make business and government operations more efficient but it is unclear whether this will continue to be the case in the long term given weaknesses in the region's economic and political environment. The region could be relegated to providing simple services that pay low wages, potentially increasing poverty in the region. Using statistics from the International Telecommunications Union, the World Bank and the International Labor organization the author has developed a panel of Latin American countries over a 20 year period to allow for comparisons across countries in the region, and to determine if countries that have invested in education and R&D also benefited from service employment with higher level skills. Initial results indicate that wireless communications, the technology of choice for these country's governments, do not create substantial employment while broadband is not yet deployed widely enough to show any effects. Factors that are found to negatively impact employment are capital formation and burdensome bureaucracies while factors found to positively affect employment are education, foreign direct investment, and, surprisingly, inequality a variable that will require further exploration. The paper concludes with policy recommendations.

1. INTRODUCTION

The purpose of this study is to determine the manner in which employment will evolve in Latin America as a result of information and communication technologies. Prior research has shown that both communication and automation are displacing certain types of employment, mainly those with middle-level skills. Given the evidence from countries with a greater penetration of information and communication technologies (ICTs), we expect Latin America to follow the same path and potentially be negatively affected by the elimination of some professions.

Researchers who have analyzed the impact of ICTs on employment have found that there has been a gradual move from agriculture to manufacturing and services, with service economies' being the latest iteration in development. The economic prospects for these service economies, however, depend on the composition of the service professions. Ideally, we should want people to be employed in professions that require higher-level skills, as these should result in higher incomes and productivity.

ICTs are actually generating employment in the Latin American region, and this is likely to be the case for some years, as these technologies make business and government operations more efficient.

In the long term, however, the problem for Latin America is that without the "knowledge and innovation policies" that invest in education, as well as research and development, the region may be relegated to providing elementary services that pay low wages, which could reduce the region to poverty.

Using statistics from the International Telecommunications Union, the World Bank and the International Labor organization, I constructed a panel of Latin American countries over a 20-year period, to determine if countries that have invested in education and R&D have also benefited from service employment with higher-level skills.

This paper is organized as follows: Section 2 presents the opportunities and potential challenges presented by ICTs. The following sections are then organized to address the different macro factors that are likely to affect employment and potentially contribute to, or counteract, the effects of technology. Section 3 discusses the role of education. Section 4 examines the impact that research and development are likely to have on this process. Section 5 focuses on the role of businesses and on how they are likely to contribute to the creation of jobs in the region. Section 6 focuses on two elements of regulation that are also associated with employment: one is the role of labor regulation in the adjustment of labor to technological development, and the other concerns more general aspects of governance, such as bureaucracy and corruption, which can also affect employment.

Section 7 presents an analysis of the data. Section 8 provides some implications of the results, as well as a discussion of limitations and a conclusion.

2. THE IMPACT OF TECHNOLOGY ON EMPLOYMENT

Information and communications technologies (ICTs) are becoming an essential part of everyone's life. An increasing amount of economic activity now takes place with the support of these technologies. They give people the ability to quickly obtain information anytime and from anywhere in the world. Data that can be accessed through networks and software applications have made tasks much easier.

Over 2 billion people now own phones with an Internet connection, and these have brought a wide range of conveniences to average people. These connections now allow people to control their home thermostats, track their exercise and heartbeat, monitor their diets, share their homes and cars, and have groceries delivered to their door. These technologies have also expanded capabilities for companies and governments. In the private sector, companies are able to control a building's energy consumption, allow access to it, find failures in production and, of course, automate many tasks that were previously done by humans, which has reduced the cost of production (Chorafas, 2011).

It is clear that technology has brought about significant changes in our lives, including, of course, the types of employment available to us. This is often desirable. We want to be able to engage in employment that is less routine and repetitive and more stimulating. People also rely on jobs for their livelihood, but the skills they possess are only able to give them access to a certain portfolio of opportunities.

A question of increasing interest is the impact technologies have on employment. Countries that have a greater penetration of ICTs are more likely to experience labor disruption faster than those with lower penetration. A 1989 study of the labor market, which looked at the impact of ICTs on employment in the United States Anderson and Harris (1989), concluded that technological trends would not drastically affect employment until the year 2000. At the time, analysis indicated that any effects on employment might not have been noticeable because many companies had not yet begun to exploit the full potential of automation tools and high-speed communication networks (Anderson & Harris, 1989). Thus, it was found at the time that ICTs were creating new jobs requiring higher skill levels, while low-skill, low-wage jobs were diminishing in industries that heavily used communications.

It has been argued, however, that the rate of unemployment is greater now than in previous periods of technology advancement. A recent book by Chorafas (2011) shows that over the last two decades, unemployment in the European Union has increased substantially for those with limited skills.
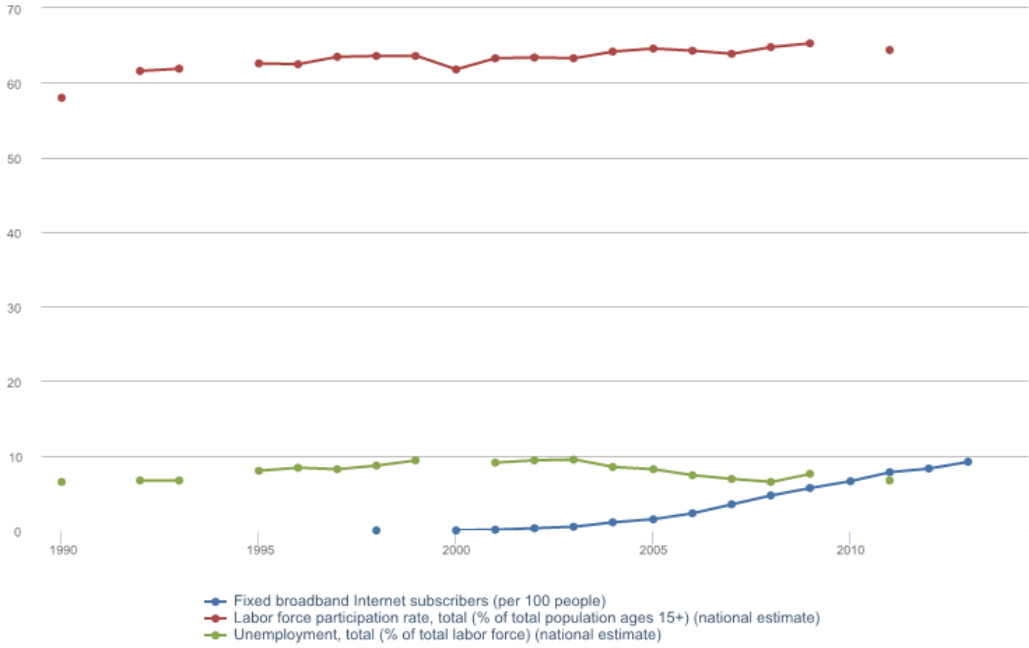
We are still in the early stages of the transition toward more highly connected and automated societies. The purpose of this paper is to determine the impact that ICTs can have on Latin America, a less-developed region.

The main hypothesis of the study is:

H1: Technology will have a negative effect with employment in services.

Figure 1. Fixed Broadband Internet (Subscribers per 100 people, 2011)

Figure 2. Labor Force Participation Rate (% of total population age 15+, 2011)

Less than 1.4   11.2 or more

Less than 59.9   66.1 or more

- Fixed broadband Internet subscribers (per 100 people)
- Labor force participation rate, total (% of total population ages 15+) (national estimate)
- Unemployment, total (% of total labor force) (national estimate)

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3. THE ROLE OF EDUCATION IN EMPLOYMENT AND DEVELOPMENT

Technology has evolved along with human development. Human ingenuity has been made evident since the dawn of civilization, presenting challenges, but also many opportunities. As technologies evolve, they require us to invest in learning to be able to take advantage of the benefits that they can have on productivity and wages. In this section, I present a brief summary of the extensive research that exists regarding the impact of education on employment.

There have been several studies of the impact of education on employment. One of the most cited is Mincer (1991) "Education and Unemployment," which showed, through an analysis of panel data, that one of the major benefits of education is a lower risk of unemployment, given higher levels of education.

A high level of education has been found to result in three benefits: higher wages, greater upward mobility in both income and occupation, and greater employment stability (Sicherman, 1990).

In 1977 and 1978, a survey by the National Opinion Research Center found that workers with the lowest levels of education expected to experience unemployment at a rate 170% higher than those with the highest levels of education (Sicherman, 1990, p. 6).

The effects of education on employment, however, are, when other variables are considered, often not significant. Mincer (1988), however, found that an additional year of education can reduce the probability of unemployment by 1.3 percentage points at different levels of experience. Similarly Riddell and Song (2012) found that an additional year of schooling resulted in a 2 percentage point increase in the probability of re-employment. There is also some evidence that people with higher levels of education are more likely to secure a permanent job after a temporary position, compared to those with less education (Charlot & Malherbet, 2013; Güell & Petrongolo, 2007) Greater skills and knowledge are also obtained through experience, and, as Sicherman (1990) indicates, there are wage increases related to job experience rather than to schooling. However, Sicherman's study also found that more educated workers engage in more training, and he believes that educated workers have a greater ability to learn and to pay for training. Education and training positively affects skills, as it results in higher productivity.

During a transition period when companies are undergoing a significant transformation, there is likely to be a great need for people educated in relevant areas, and these are likely to be offered higher wages Companies introducing technologies with a tendency for rapid evolution are also likely to rely more heavily on in-house company training to more rapidly capitalize their investments. Moreover, because of the significant changes that technology brings to all sectors during such a transition period, governments also will have to invest in education and training.

The role of education may be more difficult to discern in the future. Research thus far tells us that the more educated a person is, the more likely he or she will be employed and receive a higher wage. Up to this point, however, researchers have generally presumed that the only way people can acquire skills is through formal education. It is now possible, however, to take classes and obtain the equivalent of a degree (i.e certifications, for example) over the Internet without an institutional affiliation. From a financial perspective, it may not make sense in the future for some people to take on education-related debt, when much of the knowledge is available practically for free through online courses.

An additional difficulty is the impact that unemployment has on educational decisions. When young people find that college-educated people are having a hard time finding jobs, they, in turn, may decide that getting an education is insufficient for getting a job after graduation. Thus, persistent unemployment can have a detrimental effect on people's decisions about whether or not to become educated.

It should also be noted that in the employment and the education markets, although they are related, it is not always the case that students will steer towards careers that are in high demand. Consider the perennial problem in the US and other countries, where, for many years, there has been a great need for people with STEM skills, for which the market offers highly paid employment. When they think about education, researchers sometimes assume that the supply of educated labor perfectly correlates with marked demand. This may not necessarily be the case. A study by Chorafas (2011) found that having a college degree did not guarantee a job, because many degree holders focus on professions in soft subjects or earn degrees that are perceived to be less difficult. This may be desirable, though, as people should choose fields in which they are comfortable and competent.

In our model, we will thus try to determine how education impacts employment, assuming that a more educated population is more likely to do better in the face of rapid technological advancement. In this respect, the model will test the following hypothesis:

H2: A more highly educated population is more likely to find employment.

These initial comparisons give us an idea of how the region is educating its population. We can see, for example, that Mexico spends on education but it is not being reflected in employment as much as in Peru, where spending is lower. The same is the case with Colombia and Paraguay where a lower expenditure on education is yielding higher employment opportunity.
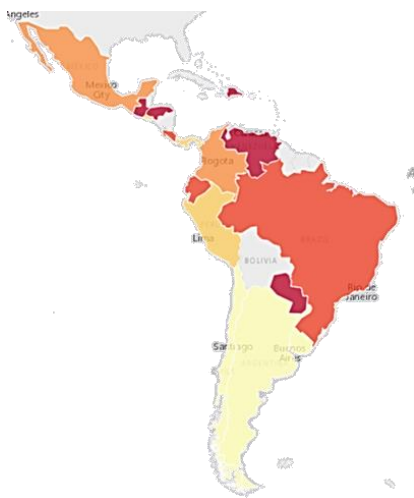
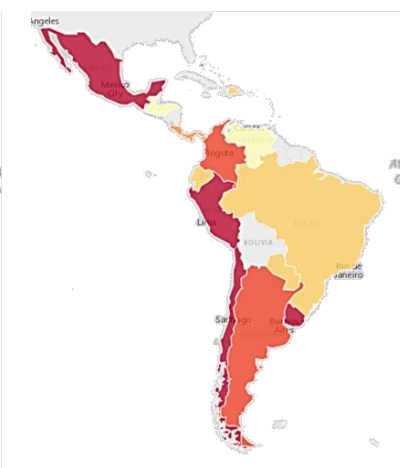**Figure 3**. Public Spending on Education, Total (% of GDP, 2011)

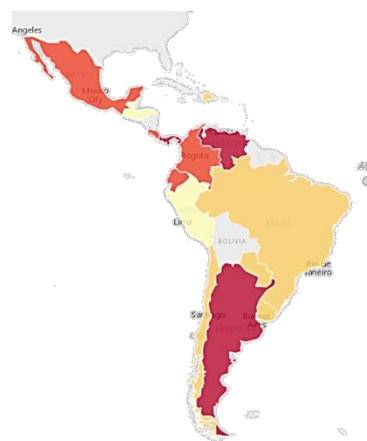**Figure 4**. Labor Force Participation Rate (% of total population age 15+, 2011)

Figure 5. Labor force Participation with Primary Education (% of total, 2011).

Figure 6. Labor Force Participation with Secondary Education (% of total, 2011).

Figure 7. Labor Force Participation with Tertiary Education (% of total, 2011).

	15 : 23
	23 : 25
	25 : 33
	33 : 38
	38 : 53

Regarding the level of education of its population we see that the region still has some work to do in educating its population. The majority of the population lacks a college degree. Surprising is Argentina where a bit less than a third of its employed population had an elementary education in 2011. Data from 2012 show that they were able to increase this to 35%. However this population goes to both high school and then college. The same is true in Mexico but to a lesser extent. Two countries with more authoritarian regimes, Paraguay and Venezuela, are doing better in educating their labor force, in terms of elementary education in Paraguay, and both that and college in Venezuela.

4. RESEARCH AND DEVELOPMENT

In a world where technology is changing rapidly, the ability of a country to adapt will be crucial for its economic survival. This is particularly true because scholars have found a positive relationship between economic growth and innovation.

The purpose of this paper is not to determine the factors that lead to innovation in Latin America, but to examine how research and development could lead to labor generating innovations or higher skills in the presence of increasingly sophisticated information and communication technologies.

There are, of course, many factors that lead to innovations, and, from a regional perspective, theorists have explained innovation on the basis of industry/sector clusters that generate creative synergies from being together (Agrawal & Cockburn, 2003; Feldman, 1994; Jaffe & Trajtenberg, 2002). Research in this area also indicates that the more companies and people are involved in similar problems, the greater the inventiveness and productivity in the sector. One could argue that there is a need for a certain number of people to work in an area for them to innovate collectively (Arrow, 1962; Romer, 1986). However there is also evidence that diversity, rather than specialized clusters, is more likely to lead to innovation.

Unfortunately, recent research about research and development in Latin America indicates that the region, even though it generated 8.7 percent of world GDP in 2013, only generated 0.19 percent of patents (Ketelhöhn & Ogliastri, 2013), and the entire region produced the same number of patents as those in Spain.

Given the limited amount of research and development that occurs in developing countries such as those in Latin America, scholars have advocated for innovation to encourage these countries to stop depending on developed countries for their production processes (Stern & Porter, 2001) . A study of entrepreneurs in Latin America found that individuals produced a certain amount of innovation because of a need for income, rather than as a result of competitive or creative processes. These are called *survival entrepreneurs*. However they are found to be unstable (Merino & Vargas, 2004) and largely do not generate advance research and innovation services.

In these studies, scholars found that the processes impeding innovation are related not only to individual factors, but also to more complex systemic elements such as regulation, the educational level of the population, and the level of international competition that local companies face.

There are, therefore, many reasons why greater amounts of research and development in a country can be beneficial at a time when technology is evolving rapidly. A more highly educated population may be more ready and able to retrain themselves to learn skills that become necessary as technology evolves. A faster transition can thus mean that, if acquired with research and development, they may not need to be unemployed for a long period of time, as they have been able to keep their skills up to date. The transaction costs of learning a new skill may be smaller than in a society with a limited pool of knowledge that participates in the use of innovative technology.

In this respect, we wish to explore the following hypothesis:

H3: The greater the amount of research and development, the higher the levels of employment.

5. THE ROLE OF BUSINESS IN EMPLOYMENT

Even though technology brings great benefits, it also brings challenges. In fact, when new technologies are introduced, society undergoes a major shock, as companies need to change their production practices, equipment and labor skills in an environment of uncertainty. We are undergoing a major transformation as computers and communication networks produce great changes in many sectors of the economy. In developed economies, the service sectors such as finance, wholesale and retail, have facilitated a radical reorganization of business, leading to significant gains in productivity (McGuckin, Spiegelman, & Van Ark, 2005; O'Mahony & Van Ark, 2003).

ICTs can be deployed in practically any field of production, making operations more efficient and potentially displacing some workers. They are also gradually becoming more ubiquitous in the private sector. Given the cost reductions and greater connectivity, and automation, it is likely that certain types of employment will be displaced.

There is a large body of academic work about the impact that companies have on employment. Special attention has been paid to small and medium enterprises (SMEs), as some researchers have found that they positively contribute to job creation. However, the original research from Birch (1981), which found that SMEs created more jobs than their larger counterparts, has been challenged; subsequent estimates found that they create jobs at levels similar to their larger counterparts, while also paying lower wages, at least according to data in the United States (Brown, 1990). Another study, by Davis and Haltiwanger (1996) in the US, showed that large companies generated most of the jobs that were created and destroyed in manufacturing in the 1972-1988 period. They also found that the amount of jobs created increased as a company increased in size. Research thus finds that both

small and large companies generate jobs, and this does not seem to correlate with the size of the enterprise.

Research also finds that new businesses are more productive than established firms (Foster, Haltiwanger, & Syverson, 2008). This can be related to the fact that new entities are more likely to adopt processes and technologies that make their employees more productive.

Companies can thus be an engine of employment creation or destruction, depending on how they use technology. If they invest in labor-saving technologies, we are likely to see a negative impact on employment. The map below shows how few companies are created. A country like Mexico for example with a population of 122 million people of which 78 million approximately are employment age only 70 million actually have employment this leaves 8 million people unemployed. If there are only 122000 companies created every year which are likely start with a handful of employees these can generate, assuming three employees, 366,000 jobs not enough to cope with the increasing demand for employment particularly if more and more companies begin to make their operations more efficient through the introduction of ICTs.
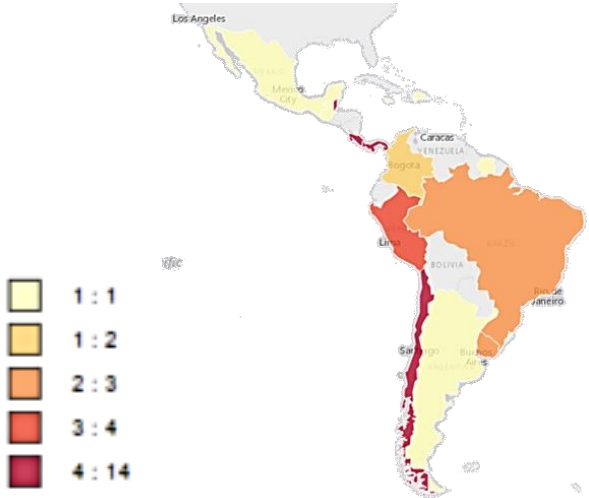
It should be noted nonetheless that many people are employed in the informal sector, which has been shown to be more likely to remain in poverty (Amuedo‑Dorantes, 2004)

In this respect, I tested the following two hypotheses.

H4: The creation of new businesses will positively affect employment levels.

H5: Capital investments will negatively affect employment, as they are more likely to be labor-saving expenditures.

Figure 8. New Business Density (New Registrations per 1.000 people ages 15-64, 2011).

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6. THE IMPACT OF GOVERNMENT ON EMPLOYMENT

There are many ways in which governments can affect employment. In this section, I focus on two areas. One is labor regulation, and the other is a government's ability to facilitate business operations.

6.1 Labor Regulation

The ability of a company to decide to invest in labor-saving technology or to hire more workers can be affected by labor regulations.

Labor regulations have been adopted in many countries to improve working conditions. These include, among other considerations, social security, pensions, health care, minimum wage laws, workers' compensation for accidents and sick leave for mothers. These, of course, come at a cost, both monetary and potentially in the form of human capital, as these protections may make companies more reluctant to hire workers, thus reducing employment opportunities.

A study by Charlot and Malherbet (2013) showed that labor regulation aiming to protect employment, benefits people who have stable jobs, as it reduces the likelihood of being fired. However, they explained, it increases turnover due to the increasing use of temporary jobs. Furthermore, well-intentioned labor regulation that protects employment also has the unintended effect of reducing the will of employers to convert a temporary worker into a permanent employee to avoid burdensome regulations and expenses.

Charlot and Malherbet (2013) also found that countries with few, if any, protections are also not good at job creation, due to job destruction and the lack of a desire to invest in education.

Specifically in Latin America, a paper by Kaplan (2009) reports that employers in the region would increase the number of workers by 2% if labor regulations were more flexible. In this respect, Botero, Djankov, La Porta, López de Silanes, and Shleifer (2003) found that countries with stronger labor regulations also experienced lower labor participation and higher unemployment.

Also in Latin America, Heckman, Pagés-Serra, Edwards, and Guidotti (2000) found that labor laws resulted in lower employment and higher inequality. Ahsan and Pagés (2009) arrived at similar results, finding that labor regulation resulted in both reduced output and employment in the formal sector. In Colombia Kugler (2004) found that reducing the cost of firing an employee also reduced unemployment. A similar result was found in Peru (Saavedra & Torero, 2004). This is because it makes the labor market more dynamic and flexible to respond to changes in technology, for example.

In addition to the effect that these regulations can have on hiring and wage decisions. Bertola (1990) also found that rigid labor regulation makes an economy more vulnerable to economic shocks, as this can affect companies' abilities to respond quickly.

A number of other studies (Gonzaga, Maloney, & Mizala, 2003; Haltiwanger, Scarpetta, & Schweiger, 2008; Micco, 2006) found that labor rigidities also reduce the productivity of workers, because they are not able to change jobs more rapidly to firms where their skills will make them more productive. This inability to move may also limit the learning that they need to better adjust to a new technological environment.
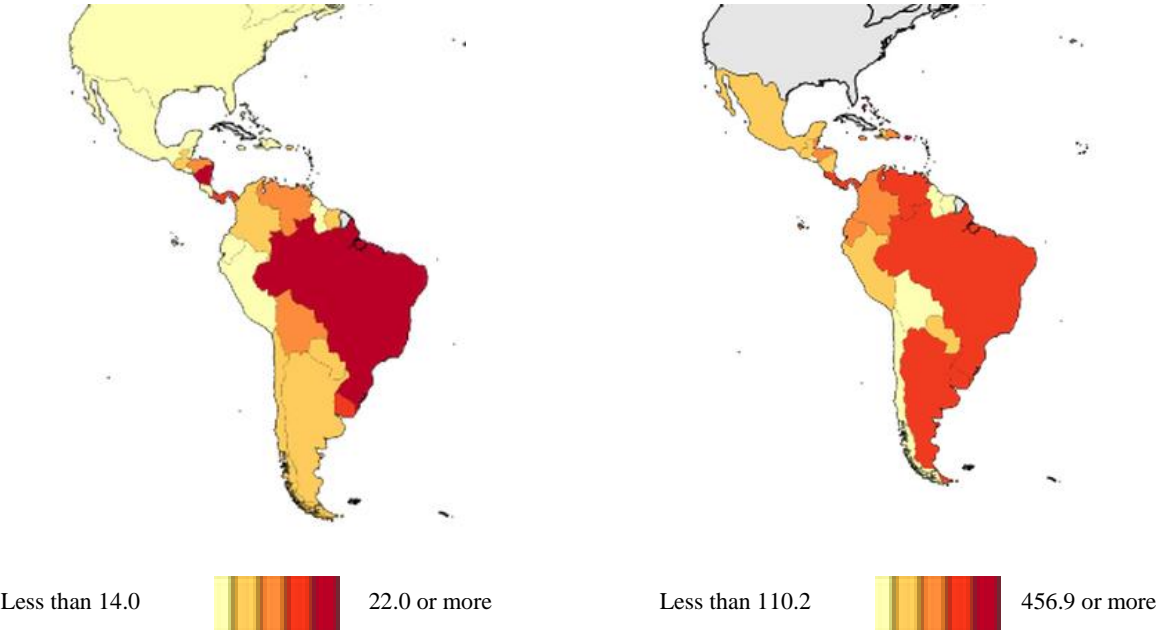
In spite of the literature that has indicated that rigid labor regulations result in lower employment, a study of Latin America alone found, from a survey of companies in 14 countries in the region, that the majority (83.2%) do not hire or fire workers as a result of rigid labor regulations. The paper argued that one of the reasons for such an unexpected result is that companies may rely on informal labor to get around regulations, but it is also possible that the laws are not actually enforced. Their empirical tests show that a more flexible labor market led to a greater number of dismissals, but they were unable to determine whether this also led to greater job creation, as the coefficient was not significant. The maps below suggest firs that at least on these two measures they don't get a lot of paid leave days and wages for apprentices are USD$332 a month which leads to an annual wage of less than USD$ 4,000

Based on the aforementioned research, I will test the following hypothesis:

H6: Labor regulation in Latin America negatively impacts employment.

Figure 9. Paid Annual Leave for a Worker 5 years of tenure (In working days).

Figure 10. Minimum Wage for a 19 Year Old or Apprentice (US$/Month, 2010).

Less than 14.0   22.0 or more

Less than 110.2   456.9 or more

6.2 Bureaucracies

In the previous section, I reported on the literature that focuses on labor regulation and the impact that scholars have found about its relationship with employment creation. Regarding regulation, there is a long tradition in economics concerning the perverse effects of burdensome bureaucracies on many aspects of economic activity.

Regulation, ideally conceived, is intended to protect employers, employees and consumers. It protects employers by limiting their liability when problems with a product arise, by protecting their assets from being stolen, and by protecting them from fraudulent activities on the part of employees, while it provides benefits for employees, such as social security; paid vacations; sick leave; and protection against unjustifiable firing and exploitative labor practices and salaries.

Regulation, nonetheless, can be intrusive and overwhelming to the point of discouraging business creation or forcing employers to hire people informally, in order to avoid paying the costs of labor compliance (Mazumdar, 1976). In a now famous study by De Soto (1989), the registration of a firm in Peru took 10 months at an estimated cost of $1,037, equivalent to 32 times the minimum monthly salary, and included $195 for licenses and other regulatory requirements. This was later compared with two U.S. cities, Florida, where it took three and a half hours, and in New York City, where it took four hours to register a new firm.

In many developing countries, excessive regulation is common, and researchers have attested to this. In the Philippines, even micro enterprises require a lawyer and an accountant to comply with regulatory requirements (Alonzo, 1991), while 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."

Labor laws are complex pieces of legislation that regulate 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.

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% of respondents) and to assign and negotiate spaces for merchants (29% of respondents.) These organizations emerged as a means of overcoming government regulations and red tape. It is much easier for these street vendors to become members of these organizations than to try to navigate government oversight on their own (Rama, 1995). The maps below give a sense of the amount of bureaucracy that prevails in the region. For comparison purposes the U.S. has an ease of doing business index of 7. In Europe Germany is at 13
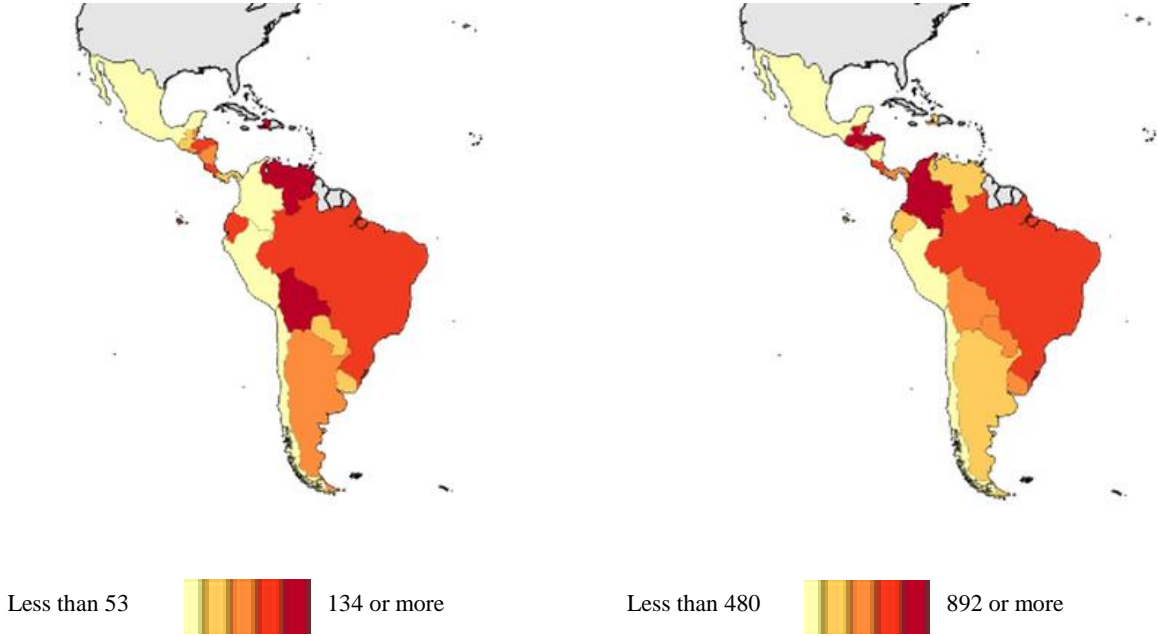
and of the less developed countries in that region Spain and Italy have an index of 33 and 52 respectively. In Mexico the index stands at 43, among the better ones, while Brazil and Argentina were at more than 100 in 2013. Regarding the number of days that it takes to enforce a contract. In 2014, it took 420 in The U.S., 394 in Germany, 395 in France, 510 in Spain, and 1,185 in Italy. In Latin America Mexico was among the best at 389 days while it took 731 days in Brazil. These levels are thus comparable to those in Europe.

Regarding bureaucracies, I test the following hypothesis:

H7: The more bureaucratic a country, the lower the level of employment.

Figure 11. Ease of Doing Business Index (1=Easiest, 185=Most Difficult, 2011).

Figure 12. Time Required to Enforce a Contract (in days), 2011.

Less than 53   134 or more

Less than 480   892 or more

7. GENERAL ECONOMIC FACTORS OF THE REGION

In addition to these more theoretically based factors, this study also controls for other factors that can affect employment levels, specifically income in the form of GDP per capita, income inequality through the GINI index, and population.

8. METHODS

Using data from the World Bank, The International Telecommunications Union and the International Labor Organization, I constructed a panel of 23 countries over a period of 15 years to determine the effects of technology on employment in Latin America. The scarce availability of comparable statistics limits more sophisticated econometric studies across countries, particularly for these developing economies.

One of the main weaknesses of country-level data is that variables can be missing. Statistics software that uses list wise deletion discards all observations that contain missing values.

A large amount of missing data can lead to less efficient results (larger standard errors, wider confidence intervals, less power) than the alternative used here of multiple imputation (MI). If only actual data are used, then the results do not represent the population, and biases result from list wise deletion.
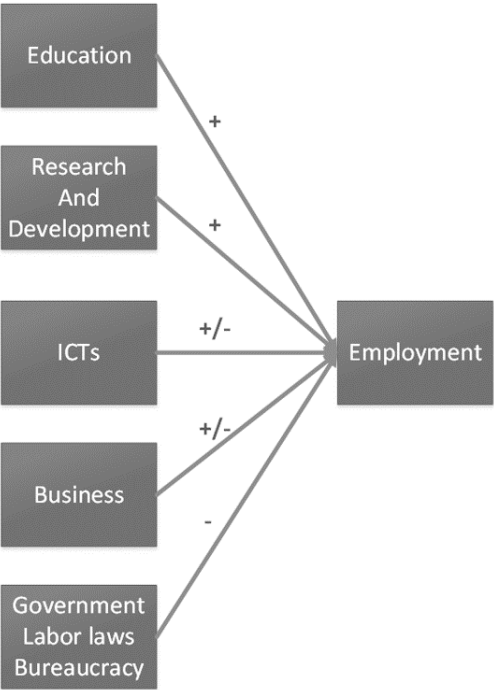
The alternative that I chose is to use multiple imputations to fill the gaps where data is missing, in order to make deductions about the nature of the problem in certain countries. This technique has been proven to be superior to any other method {King, 2001 #160}. Without multiple imputations, it would have been impossible to perform any type of analysis. The results, thus, need to be viewed with caution, and we suggest that any policy recommendations focus on the factors that are significant, as opposed to the specific magnitude of the coefficients.

Because we are working with panel data, we used a fixed data regression analysis.

8.1 Model

Figure 13 shows the relationships of the factors I found in the literature that can affect employment. The model is a fixed-effects regression with employment in the service sector as the dependent variable because of the large number of people that are employed in that sector. The rationale for this is that technology does not affect employment directly. In other words, a technology cannot employ a person, while a business can. It is for this reason that the model includes in the first stage, the variables that can affect new businesses and their decision to enter the market which include the ICT variables *mobile* and *broadband* (See figure 13).

Figure 13. Model of the Relationship of factors to employment.

8.2 Results

Figure 14 shows the results of the regression for each of the variables included in the model. The graph only reports the factors that were statistically significant.

Figure 14. Significant Factors Affecting Employment.

The main hypothesis of this study addresses the impact of ICTs on employment. We found first that of the two technologies included in the study both Internet and broadband were significant. The Internet variable is about the number of users in the country while broadband is about subscriptions. The region is still quite low in broadband penetration, which barely extends beyond 10 percent of the population. It is thus not surprising that the effect is positive as this being a multi-purpose technology opens multiple opportunities for employment. People can take advantage of this connectivity to enhance their skills and even be self-employed as is happening in many other regions of the world with websites such as Etsi, where people sell crafts. The number of Internet subscribers, on the other hand, has a negative effect on service employment. These are users that can be accessing the network from multiple locations such as at jobs, schools, or cafes. In this case, it is possible that the connectivity that users are experiencing at a broader set of establishments is beginning to show instances of technology derived unemployment. Mobile phones are much more pervasive in the region however they do not appear to be either helpful or harmful to service employment. Additional data about smart phones could provide a more accurate estimation of the effect of mobile given that applications such as Uber and AirB&B can negatively affect the service sector that employs most of the labor in the region. The import of ICTs shows a positive impact on service employment, which may be related to the amount of investment that is happening in the region as countries expand their connectivity.

Of the control factors, education is significant and negative. While the results only show primary education the same result was found when tertiary education was included. This final model drops one of the education variables because of multicollinearity problems. This shows that an increase in education does not alleviate unemployment and, in fact, reduces employment in the service sector. The region still suffers from low levels of education and all of the countries are listed close to the bottom of the PISA rankings. This means that even those that attend school do not get a very good education. Educated people may also be unable to find jobs in the service sector as many of these jobs are basic and the manufacturing sector is small.

The private sector shows both positive and negative effects on employment. As expected, the introduction of capital, which in this study is assumed to represent the introduction of more automation, is negative and significant. This is an assumption that needs to be further explored, taking into consideration that Latin America still has a comparative advantage on labor costs. Although wages have increased, the region's labor is inexpensive compared to that of the United States or Canada, their most industrialized neighbors. If this trend continues it can have potentially disastrous economic effects on the region's employment.

The variable self-employment was included in the models simply to capture alternative sources of employment that do not rely on an established business. It is not surprising that as more people are self-employed it reduces the number of people employed in the service sector.

Labor regulations were expected to be negative as they are presented that way in the literature. However in this study paid leave for a person that has been employed for five years has a positive effect on service employment. This is, of course, counterintuitive, as paid leave raises the cost of labor, but it is possible that benefits such as this make people more determined to find and keep employment.

Another significant variable in the model is the level of bureaucracy. The effect is positive which means that a higher index implies more difficulties doing business and more employment in the service sector. The data shows that the ease of doing business is actually improving in some countries with some having a similar level to that of less developed European countries. Because this result is counterintuitive it may be capturing the re-regulation of markets as a result of economic crisis and high levels of unemployment. This may restore some jobs.

Corruption in government has, as expected, a negative effect on employment. The two other control variables, population and GDP per capita, both have a positive effect, meaning that larger and wealthier populations will naturally lead to more people finding themselves employed in the service sector.

9. POLICY RECOMMENDATIONS

The results of this study suggest that, like developed countries, the region is beginning to experienced negative effects that stem from the wider penetration of the Internet, and the negative effect of gross capital formation furthers suggest that, at least in the short term, we will see a contraction in employment. This can be catastrophic in a region that still suffers from weak governments, some even completely inadequate, ineffective and corrupt, as well as from significant incidents of violence. In the absence of policies that can alleviate potential further erosion in employment, the regions could spiral into economic hardship, potentially followed by social unrest.

The question is what to do? Research from other countries points to the need for quality education that better matches market demands. For the most part, education has been considered a public good to be provided by the state. However, given the challenges associated with the speed at which technology advances, this role should be expanded to other entities, such as the private and non-for profit sectors, to support a population that will need to be constantly updating its skills to maintain employability over time, as technologies continue to evolve. This means that training should be part of the operations of a company, in order to address the demands of a more technologically sophisticated, global market place.

Greater efforts should be made in the region to improve research and development capabilities. In this area, the region is still in its infancy and is still a net importer of technology, at great expense, both financially and, as is made evident by this paper, in employment. Governments should thus be concerned with enhancing their population's science, technology, engineering and mathematics (STEM) skills, to open up opportunities to contribute to this post-industrial digital economy.

Given the confluence of economic and political challenges that the world and the region are currently experiencing, governments will need to take a much more active, but not intrusive, role to ameliorate the negative impact that technology is likely to bring in the near future.

10. CONCLUSIONS

ICTs and automation are becoming more pervasive around the world, and studies to date have shown a negative effect on employment, at least in the short term. This study further contributes to that literature, while also showing deficiencies in the generation of employment, arising from the introduction of capital which can be robotics and greater Internet connectivity. The region, without significant government intervention, is likely to suffer serious economic conditions. It needs to aggressively invest in education, research and development, and providing incentives for the private sector to invest in training.

The region is still growing its population, which means that there will be additional pressure on the market for employment opportunities from a young population which, if disenfranchised, can cause serious economic and, consequently, political instability.

Governments in the region have some time to adjust, but they cannot wait long, as the effects of these technologies are already evident, and the trends are likely to continue.

11. REFERENCES

Agrawal, A., & Cockburn, I. (2003). The Anchor Tenant Hypothesis: Exploring the Role of Large, Local, R&D-Intensive Firms in Regional Innovation Systems. *International Journal of Industrial Organization, 21*(9), 1227-1253. doi: http://dx.doi.org/10.1016/S0167-7187(03)00081-X

Ahsan, A., & Pagés, C. (2009). Are all labor regulations equal?: evidence from Indian manufacturing. *Journal of Comparative Economics, 37*(1), 62-75. doi: 10.1016/j.jce.2008.09.001

Amuedo‐Dorantes, C. (2004). Determinants and poverty implications of informal sector work in Chile. *Economic Development and Cultural Change, 52*(2), 347-368. doi: 10.1086/380926

Anderson, J. M., & Harris, S. (1989). Communications and future employment trends. *Telematics and Informatics, 6*(2), 71-80. doi: 10.1016/S0736-5853(89)80035-8

Arrow, K. J. (1962). The Economic Implications of Learning by Doing. *The Review of Economic Studies, 29*(3), 155-173.

Bertola, G. (1990). Job security, employment and wages. *European Economic Review, 34*(4), 851-879. doi: 10.1016/0014-2921(90)90066-8

Birch, D. L. (1981). Who creates jobs. *Public Interest*(65), 3-14.

Botero, J. C., Djankov, S., La Porta, R., López de Silanes, F., & Shleifer, A. (2003). The regulation of labor. *NBER working paper*(w9756).

Brown, C. (1990). *Employers large and small*: Harvard University Press.

Charlot, O., & Malherbet. (2013). Education and employment protection. *Labour economics, 20*, 3-23. doi: 10.1016/j.labeco.2012.09.004

Chorafas, D. N. (2011). *Education and Employment in the European Union : The Social Cost of Business*. Farnham: Ashgate Publishing Ltd.

Davis, S. J., & Haltiwanger. (1996). Small Business and Job Creation: Dissecting the Myth and Reassessing the Facts. *Small business economics, 8*(4), 297.

Feldman, M. P. (1994). *The geography of innovation* (Vol. 2; 2.). Dordrecht; Boston: Kluwer Academic.

Foster, L., Haltiwanger, J., & Syverson, C. (2008). Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability? *The American Economic Review, 98*(1), 394-425. doi: http://dx.doi.org/10.1257/aer.98.1.394

Gonzaga, G., Maloney, W. F., & Mizala, A. (2003). Labor Turnover and Labor Legislation in Brazil [with Comments]. *Economía*, 165-222.

Güell, M., & Petrongolo, B. (2007). How binding are legal limits? Transitions from temporary to permanent work in Spain. *Labour economics, 14*(2), 153-183. doi: http://dx.doi.org/10.1016/j.labeco.2005.09.001

Haltiwanger, J., Scarpetta, S., & Schweiger, H. (2008). Assessing job flows across countries: The role of industry, firm size and regulations: National Bureau of Economic Research.

Heckman, J., Pagés-Serra, C., Edwards, A. C., & Guidotti, P. (2000). The Cost of Job Security Regulation: Evidence from Latin American Labor Markets [with Comments]. *Economía, 1*(1), 109-154. doi: 10.1353/eco.2000.0007

Jaffe, A. B., & Trajtenberg, M. (2002). *Patents, citations, and innovations: A window on the knowledge economy*.

Kaplan, D. S. (2009). Job Creation and Labor Reform in Latin America. *Journal of Comparative Economics, 37*(1), 91-105. doi: http://dx.doi.org/10.1016/j.jce.2008.10.002

Ketelhöhn, N., & Ogliastri, E. (2013). Introduction: innovation in Latin America. *Academia Revista Latinoamericana de Administración, 26*(1), 12-32. doi: 10.1108/ARLA-05-2013-0037

Kugler, A. (2004). The effect of job security regulations on labor market flexibility: Evidence from the Colombian labor market reform. In J. J. Heckman & C. e. Pages (Eds.), *Law and employment: Lessons from Latin America and the Caribbean* (pp. ix-ix): University of Chicago Press.

McGuckin, R. H., Spiegelman, M., & Van Ark, B. (2005). The US advantage in retail and wholesale trade performance: how can Europe catch up? *Perspectives on a Global Economy*.

Merino, M., & Vargas, M. (2004). Evaluacioin comparativa del potencial emprendedor de Latinoamerica: una perspectiva multinivel. *Academia Revista Latinoamericana de Administración, 46*(46), 38-54.

Micco, A. (2006). The economic effects of employment protection: evidence from international industry-level data.

Mincer, J. (1988). *Studies in Human Capital*. VermBrookfield, VT: Edward Elgar Publishing Company.

Mincer, J. (1991). Education and unemployment. *NBER Working Paper No. 3838.* from http://www.nber.org/papers/w3838

O'Mahony, M., & Van Ark, B. (2003). *EU productivity and competitiveness: an industry perspective: can Europe resume the catching-up process?* : Office for Official Publications of the European Communities Luxembourg.

Riddell, W. C., & Song, X. (2012). Does Education Reduce Unemployment? New Evidence on the Impact of Education on Unemployment and Re-employment. *Intereconomics*(1), 16-22.

Romer, P. M. (1986). Increasing returns and long-run growth. *The journal of political economy, 94*(5), 1002-1037. doi: 10.1086/261420

Saavedra, J., & Torero, M. (2004). Labor market reforms and their impact on formal labor demand and job market turnover: The case of Peru. In J. J. Heckman & C. e. Pages (Eds.), *Law and employment: Lessons from Latin America and the Caribbean* (pp. ix-ix): University of Chicago Press.

Sicherman, N. (1990). Education and occupational mobility. *Economics of Education Review, 9*(2), 163-179.

Stern, S., & Porter, M. (2001). Innovation: location matters. *Sloan management review, 42*(4), 28.

APPENDIX 1. DATA DEFINITIONS

DEFINITION	ABREVIATION	DEFINITION
Internet users (per 100 people)	Internetim	Internet users are people with access to the worldwide network.
Fixed broadband Internet subscribers (per 100 people)	Fbroadbandim	Fixed broadband Internet subscribers are the number of broadband subscribers with a digital subscriber line, cable modem, or other high-speed technology
Mobile cellular subscriptions (per 100 people)	Mobileim	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service using cellular technology, which provide access to the public switched telephone network. Post-paid and prepaid subscriptions are included.
Labor force with primary education, male (% of male labor force)	Lbrpriedim	Lbrpriedim
Expenditures for research and development.	Rndexpim	Expenditures for research and development are current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development.
ICT goods imports (% total goods imports)	Ictimprtsim	Information and communication technology goods imports include telecommunications, audio and video, computer and related equipment; electronic components; and other information and communication technology goods. Software is excluded.

Gross capital formation (% of GDP)	Grosscapprivim	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.
New business density (new registrations per 1,000 people ages 15-64)	Newbusdenim	New businesses registered are the number of new limited liability corporations registered in the calendar year.
Foreign direct investment, net inflows (% of GDP)	Fdiinim	Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments.
Industry, value added (% of GDP)	Industryivaim	Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of

		value added is determined by the International Standard Industrial Classification (ISIC), revision 3. Note: For VAB countries, gross value added at factor cost is used as the denominator.
Agriculture, value added (% of GDP)	Agriva	Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3. Note: For VAB countries, gross value added at factor cost is used as the denominator.
Self-employed, total (% of total employed) SL.	Selfempl	Self- employed workers are those workers who, working on their own account or with one or a few partners or in cooperative, hold the type of jobs defined as a "self-employment jobs" (i.e. jobs where the remuneration is directly dependent upon the profits derived from the goods and services produced). Self-employed workers include three subcategories: employers, own-account workers, and members of producers' cooperatives.
Paid annual leave for a worker with 5 years of tenure (in working days)	pidleav5im	
Severance pay for redundancy dismissal (for a worker with 5 years of tenure, in salary weeks)	sevpay5yrim	
Ease of doing business index (1=most business-friendly regulations	Easeim	Ease of doing business ranks economies from 1 to 183, with first place being the best. A high ranking (a low numerical rank) means that the regulatory environment is conducive to business

		operation. The index averages the country's percentile rankings on 10 topics covered in the World Bank's Doing Business. The ranking on each topic is the simple average of the percentile rankings on its component indicators.
	paygovoffim	
Time required to enforce a contract (days)	Timecntrctim	Time required to enforce a contract is the number of calendar days from the filing of the lawsuit in court until the final determination and, in appropriate cases, payment.
Time to prepare and pay taxes (hours)	Timetaxesim	Time to prepare and pay taxes is the time, in hours per year, it takes to prepare, file, and pay (or withhold) three major types of taxes: the corporate income tax, the value added or sales tax, and labor taxes, including payroll taxes and social security contributions.
Time required to start a business (days)	Timestrtbussim	Time required to start a business is the number of calendar days needed to complete the procedures to legally operate a business. If a procedure can be speeded up at additional cost, the fastest procedure, independent of cost, is chosen.
Population ages 15-64 (% of total)	pop1564im	Population ages 15 to 64 is the percentage of the total population that is in the age group 15 to 64. Population is based on the de facto definition of population.
GDP per capita (constant 2000 US$)	Gdppcim	GDP per capita is gross domestic product divided by midyear population. GDP 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 depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant U.S. dollars.

APPENDIX 2. REGRESSION RESULTS

EMPLSERVIM	COEF.	STD. ERR.	T	P>T
internetim	-0.08737	0.040538	-2.16	0.032
fbroadbandim	0.176569	0.084173	2.1	0.036
mobileim	-0.02147	0.013584	-1.58	0.115
lbrpriedim	-0.08271	0.028325	-2.92	0.004
rndexpim	0.627854	0.765775	0.82	0.413
ictimprtsim	0.291093	0.074897	3.89	0
grosscapprivim	-0.47552	0.068883	-6.9	0
newbusdenim	0.182327	0.103837	1.76	0.08
fdiinim	0.040344	0.105714	0.38	0.703
industryivaim	0.020852	0.050775	0.41	0.682
agriva	0.092924	0.087152	1.07	0.294
selfempl	-0.14088	0.038308	-3.68	0
pidleav5im	0.221254	0.095284	2.32	0.021
sevpay5yrim	0.017781	0.042074	0.42	0.673
easeim	0.031175	0.013637	2.29	0.023
paygovoffim	-0.23085	0.026397	-8.75	0
timecntrctim	-4.3E-05	0.001437	-0.03	0.976
timetaxesim	0.000709	0.001047	0.68	0.499
timestrtbussim	-0.00328	0.010243	-0.32	0.749
pop1564im	0.815486	0.183456	4.45	0
gdppcim	0.000353	9.46E-05	3.73	0
_cons	17.14784	12.17823	1.41	0.161