Technological Change and Its Impact on Skilled Jobs: The Case of Mexico[1]

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Abstract--**Technological change has always had a strong influence on the economy. In the case of the Information and Communications Technologies (ICT), their incessant penetration has transformed traditional working places, such as the office. Although many white collar activities have survived given the enduring reliance on qualified staff with abundant skills and experience, they now seem at risk due the progressive automation of clerical work. These trends are not exclusive of industrialized nations, though. Then, we pose the following question: to what extent is technological change affecting skilled jobs in developing nations too, and more specifically in Mexico? In attempting to answer this question, we examine the impact of ICTs on six skilled jobs in Mexico City: data entry keyers, photographers, computer systems analysts, messengers, stenographers and lathe operators. We found that traditional occupations have indeed disappeared, whereas specialized manufacturing jobs, such as lathe operators, seem to be still required by the market, although in a lesser extent. We conclude that jobs are no longer defined by traditional skills but by multitasks abilities, especially in ICTs.**

I. INTRODUCTION

Since the start of the industrial revolution, technology has frequently been accused of affecting workers. As, for example, with the disruptive nature of such pioneering inventions as the spinning mill and the steam engine, which were at the core of England's social riots of the 1810's and these protesters became known as "Luddites" [17]. However, history shows that new technologies not only disrupt the *status quo* but also tend to bring about beneficial changes in society. No wonder that the rapid advance of information and communications technologies (ICTs) has revived these topics due to the drastic changes that computers have brought to a large list of productive activities, which has shaped the current economic landscape from that existing just thirty years ago, as Brynjolfsson and McAfee have pointed out [5].

Clearly ICTs diffusion has been an astonishing phenomenon. During the early 1980s, computers started appearing at few homes and offices. They were firstly used by scientists, engineers and specialists to solve complicated calculations. As time went by, digital machines became more sophisticated and easier to operate. Thanks to the coming of user-friendly software, home computers were rapidly embraced by ordinary consumers [8].

Because desktop computers started to be ubiquitous, an increasing number of software packages emerged but thus the so-called Wintel architecture swiftly became dominant[2]. In this respect, Borrus and Zysman [3] argue that "Wintelism" reflected a shift in competitive dynamics away from final assembly and vertical market control, toward a struggle over setting and evolving de facto product standards. As a result, in few years the Wintel architecture ended transforming several office chores by systematizing repetitive tasks. Among the first duties to be affected were those carried out by low-skilled clerical staff [1], [2], [7], [12].

In the case of developing nations, ICT diffusion has been far slower, and its displacement effects much less evident [21]. Nonetheless, the presence of computers at offices and factories in less developed countries began to increase as early as 1990, with some office occupations—especially those requiring manual skills—beginning to decline due to the advent of word processors and the electronic mail [18]. It is hardly surprising, therefore, that the increasing presence of ICTs at work started to question the rationale for employing large pools of typists and messengers, first, and later of secretaries and assistants.

In Mexico, the introduction of ICTs has been uneven because its penetration has not been as swift as originally expected. One of the main factors affecting Internet penetration is the monopolistic structure of the Mexican telecommunications sector, which has hampered competitive investments and thus the widespread introduction of broadband [20]. Nonetheless, Internet penetration remains weak for international standards with only 30% of households having an Internet connection, whereas 37% had at least either a desktop or a laptop in 2012 [14].

Given the mediocre penetration of ICTs in Mexico, it looks appropriate to pose the following question: to what extent has technological change altered the demand for skilled jobs in Mexico, particularly those directly affected by the diffusion of ICTs? In order to provide an answer to this question, this paper analyzes the historical record of employment offerings in six job categories in the labor market of Mexico City. Data were gathered from searching the monthly offers for six different occupations that a leading national newspaper published in its classified ads section from 1980 to 2012. These jobs were: data entry keyers (data typists), photographers, computer systems analysts, messengers, stenographers and lathe operators. Empirical findings are reported below.

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[2] The Wintel architecture refers to the coupling of Microsoft's operating system running on Intel's chips that became the dominant design for desktop computers in the early 1990s.

II. TECHNOLOGICAL CHANGE AND EMPLOYMENT

Although empirical findings on innovation suggest that technological change spurs economic growth, some jobs may go during the adapting process especially in routine activities requiring little knowledge and skills. Moreover, vulnerable workers can be endangered if the technique with which they are associated is superseded by the newer one. In the long-run, however, the incoming innovations tend to generate new occupations that ask the workforce for improved skills [22], [26], [30].

This is a recurring situation, though. During the industrial revolution, the overall substitution of capital for labor (through mechanization), raised the question of the impact of technology on employment for the first time in history. At that time, peasants were moving from agriculture toward factories. Once a large share of the workforce became directly dependent upon industrial jobs, technical change appeared as a real threat, as the Luddites knew [17], [22]. But early economists had to seek for an explanation given the increasing social unrest. This analysis became known as "the compensation theory," according to which the jobs displaced in a given activity would be replaced, first through an enlarged production of machinery itself, and second by means of increases in the level of demand brought about by a reduction in prices generated by the introduction of new techniques [26], [30].

Although this phenomenon progressively delivers a net gain in total employment, as new industries replace traditional ones and thus creating and expanding needs, the current rapid advance of ICTs has been recently blamed for rendering several jobs redundant, with many of them in the service sector [4], [5], [28].

In the case of the United Kingdom, for example, Sinden [25] reports that productivity improvements in the British banking sector due to the introduction of ICTs have enabled staff reductions by replacing workers with technology in the execution of back-office processing tasks. It is worth noting that productivity has a horizontal effect: as businesses adopt better technology, organizational processes and practices, workers can produce more. Then, as profits rise, so will demand for labor; and better living standards will lead to higher ambitions and better education, completing the virtuous cycle. Besides, the mounting diffusion of new organizational practices increases demand for skilled workers [1], [19].

Labor-related technological changes have been particularly noted in urban settings where competition for job offers is fierce. This is because large cities attract talent, which in turn nurtures business opportunities. Several studies show that growing cities tend to catch the attention of innovative entrepreneurs who also seek for highly trained workers to joint their ventures [10], [15], [21], [27].

In this respect, a recent study on the effect of technological change on urban employment in the United States has found that highly trained workers have harnessed the advent of new technologies such as biotechnology, nanotechnology and information technology by moving to high-growth cities where technology start-ups are flourishing and knowledge spillovers are spreading [15]. Additionally, Moretti also points out that, in hi-tech urban settings, job opportunities are not only growing for scientists and engineers but also for less skilled workers, such as gardeners, cookers and school teachers, as the city's economy expansion demands a wider range of services [16].

Even though ICTs are rapidly changing the structure of advanced economies, technology should not be blamed for job redundancies because its long-term employment effect tend to be good as long as the mechanisms for translating technology into jobs are not hampered by institutional deficiencies, such as a lack of up-to-date university careers and/or poorly designed re-training courses [21], [30].

III. TECHNOLOGICAL CHANGE IN THE OFFICE

Changes in office employment due to the introduction of ICTs have been heralded as early as the 1970s. In an article published on June 30, 1975, the magazine *Business Week* reported that "The office is the last corporate holdout to the automation tide that has swept through the factory and the accounting department. *It has changed little since the invention of the typewriter 100 years ago* (emphasis added). But in almost a matter of months, office automation has emerged as a full-blown systems approach that will revolutionize how offices work." The article also reports views and perceptions provided by pundits such as George E. Pake, who headed Xerox Corp.'s Palo Alto Research Center, and ventured to give a forecast of how would the office of the future be: "in 1995 my office will be completely different; there will be a TV-display terminal with keyboard sitting on my desk. I'll be able to call up documents from my files on the screen, or by pressing a button. I can get my mail or any messages[3]".

Although George Pake's predictions proved to be remarkably accurate, the main implications of the coming of the "paperless office" meant almost exclusively that hard copy (i.e., printed paper) was irremediable going to disappear. Nonetheless, time has shown that paper extinction has not yet been happening because people are still reluctant to give it up thanks to its tangibility, practicality and efficiency [24].

Yet, the advent of ICTs in the office has brought out changes in routines, posts and even the emergence of a brand new social culture, epitomized by the widespread diffusion of social networks at work. To some extent, this phenomenon can be dubbed as "the ubiquitous office" because wireless connections enable you "to be in your office" everywhere,

[3] The article can be found at http://www.businessweek.com/stories/1975-06-30/the-office-of-the-futurebusinessweek-business-news-stock-market-and-financial-advice [Retrivied on January 27, 2014].

anytime[4]. As a result, work from legions of file clerks has been transformed by the stroke of a function key. So, accuracy and speed in which workflows are processed have increased dramatically. Therefore, many occupations inside an office cannot be simply tagged as monotonous work. In this respect, Alison Kidd draws a distinction between "knowledge workers" and other categories, such as clerical workers. She found that clerical workers use information—about, say, customer orders—to aid the smooth working of the organization, whereas knowledge workers use information to change themselves. Interestingly, she observed that knowledge workers take notes not in order to store information, but because the process of note-taking helps them to learn. Nonetheless, once taken, notes are rarely reviewed [11].

The education system plays a crucial role in the transition from traditional mass production to knowledge economy occupations. According to the Organisation for Economic Co-operation and Development (OECD), knowledge-based jobs have grown rapidly, suggesting that rapid technological change is an example of how expanding higher education can generate new types of employment [21]. Nonetheless, not all nations have caught up to this trend at the same pace. Take for example, the case of northern European countries where science and technology jobs account for about four in every 10 positions [20], whereas these technology jobs are only a small fraction of the workforce in China and India. The OECD concludes that there are substantial economic benefits from investing in higher education because it can create new jobs for the better-educated as unskilled jobs in the manufacturing and service sectors disappear [21]. In economic terms, the supply of skilled personnel constitutes one of the key factors for an enterprise to initiate and pursue necessary changes in its organization and the adoption of new production technology or the introduction of new products and services. The mastery of complex technology requires highly skilled personnel. The supply and quality of the human capital are factors that determine a firm's capacity and potential to develop and change [19].

In flexible enterprises technological changes are implemented more easily because flexible firms are able to adapt more easily by changing their structures when new challenges occur. This can be seen in particular when ICTs are introduced at the work place. As pointed out by Cyert and Mowery [7], the arrival of ICTs in the office triggered a revolution by altering long established routines. Take, for example, the secretary job, which has been transformed by digital technologies. This job was a twentieth century invention as modern enterprises became complex organizations that started cutting administrative costs by introducing more efficient activities and standardized tasks. Nowadays, this epitomical clerical job is omnipresent and hugely crucial for women, with its survival being sustained by a widespread paper work culture, although the widespread diffusion of electronic hardware has obliged secretaries to master new skills [7], [24].

The gradual digitalization, automation and remote communications at offices have already dismissed many traditional clerical jobs. As pointed out by Brynjolfsson and McAfee [5], new devices such as digital voice recorders and voice-recognition software are substituting many competent secretaries because they are cheaper and more flexible. According to Autor et al. [2], the displacement of wetware by both software and hardware is the effect of the ongoing deepening of capital investments, which started in the 1990s and accelerated in the early 2000.

Due to the transcendence of these changes, *The Economist* magazine has recently published a survey of today's technology on tomorrow's jobs. It highlights that this wave of technological disruption to the job market has only just started, and innovations that already exist could destroy swathes of jobs that have hitherto been untouched, with the public sector as an obvious target. The survey shows that, until now, the jobs most vulnerable to machines were those involving routine, repetitive tasks. But thanks to the exponential rise in processing power and the ubiquity of digitized information, computers are increasingly able to perform complicated tasks more cheaply and effectively than people. As a result, clever robots can quickly "learn" a set of human actions. So, jobs in services may be even more vulnerable [28].

In terms of what jobs are most at risk, a recent study by Frey and Osborne suggests that 47% of American jobs could be automated in the next two decades. They estimated the probability of computerization for 70 different jobs and found that order clerks, brokerage clerks, insurance claims and policy processing clerks, data entry keyers, library technicians, new accounts clerks, photographic process workers and processing machine operators, tax preparers, cargo and freight agents, watch repairers, insurance underwriters, mathematical technicians, title examiners and telemarketers are among the occupations most likely to be automated in the near future, and according to these academics, wages and educational attainment exhibit a strong negative relationship with an occupation's probability of computerization [9].

The current occupational structure of industry and services in advances economies suggests a dynamic transition toward upskilling, as pointed out by Enrico Moretti [16]. Yet, the upskilling trend is more visible in manufacturing than in services. The shift to higher skilled jobs has occurred primarily within industries, rather than between them, and upskilling has occurred faster in industries that have higher than average R&D expenditures and growth rates in the number of patents. Besides, human capital has accumulated faster in those sectors which were more intensive in the use

[4] From a technical point of view, the Japanese firm Sharp has developed a mobile solution to allow executives to travel light, take nothing more than their mobile phone with them, and be still able to use network-connected peripherals around them. See the article at: http://www.sharp.co.jp/corporate/rd/24/pdf/89-06.pdf [Retrivied on January 29, 2014].

of high skilled workers since the onset. As regard the dynamics of employment, it has grown fastest in high-skilled jobs, while it has even declined in low-skilled jobs [21].

IV. ICTS IN MEXICO

ICTs are considered general purpose technologies because they serve as a platform for the operation of several different applications and programs. ICTs' most conspicuous component is the Internet, which started its global reach during the 1990s [4].

In Mexico, as in many other developing countries, the Internet was first diffused by universities and research centers, which also became the first nodes of the network. In historical terms, the advance of the Internet in Mexico can be described in four distinct phases: an introductory phase, a developmental phase, a concentration phase (duopoly), and a competitive phase. The transition from one phase to the next was determined by special circumstances that help explain the current state of the Internet in Mexico [14].

It was during the concentration phase (1996-98) that Mexico's monopolistic telco—Telmex—began commercializing backbone connections and net services. By harnessing its landline network, the firm easily dominated the household market. Although some legal barriers to competition were removed during this phase, several factors impeded the development of potential competitors. Among the most significant obstacles were the large investments needed to set up an operational infrastructure. This barrier quickly loomed impossible to surmount as Telmex had already extended its national backbones.

The problem for any potential entrant wishing to bid in the Mexican market was that it needed to invest heavily in deploying their own infrastructure before being even able to compete. Still, with the help of foreign investment, some firms sought the way to enter and, by 1999, Alestra and Avantel had established themselves as strong competitors but only in the largest markets, such as Mexico City, Monterrey and Guadalajara. Although the connection speed (that is, the amount of bandwidth offered) grew considerably during the early years, access costs have not currently gone down as quickly as desirable because of the 2008 economic recession. Besides, competition rules remains messy and potential investors are still reluctant to enter. As a result, quality of service has not increased as much as expected, and the country started to fall behind as a Latin American leader in the telecomm industry [14].

Besides, the country is now facing far more complex challenges but initial problems are only growing. For example, there is an urgent need to provide technological services to a larger portion of the population that seek to catch up with trendy Internet applications. The problem is that Telmex has a mandate to offer full-fledged telephonic services in poorer, mostly rural, areas of the nation but in doing so Internet services must be provided at lower profit levels, or even at a loss, and the company has sought to subsidize rural services by charging higher fares in the more profitable urban markets. In view of these shortcomings, the government launched the e-Mexico project in 2001 seeking to deliver ICT services to the poorer citizens. In its origins, the initiative managed a $400 million budget aiming to provide Internet access for the whole of the country, especially for the most remote and inaccessible villages. At the beginning, both government and industry contribute to the project but soon afterwards the program began to fail due to the lack of nationally-wide and well-organized operating structures, capable managers, and skilled human resources [14]. After thirteen years, the government became bogged down in successive lackluster initiatives, unable to articulate a coherent strategy, and thus provoking that the country has steadily been losing positions in many global competitive rankings. No wonder Mexico's ICTs adoption rate is the lowest among the OECD members.

All in all, technological change has continued its inexorable advance while Mexican firms have been forced to cope with the existing conditions. That means that the vast majority of businesses have been unable to master newer technologies, whereas only a handful of firms have transformed themselves in "global contenders" trough the adoption of ICTs [23]. In the case of the manufacturing sector technological change has progressed through innovations embedded in machinery and equipment thanks to the widespread availability of new and cheaper machines, frequently imported from China and the southeastern Asian region [6]. In the case of the service sector, technological change is most visible in financial services, health and education mostly due to their urban nature and relative sophistication that eases the introduction of new technologies. López [13] and Valdivia and colleagues [29] have documented the transition of Mexico City's traditional economy toward a knowledge-based one though the upskilling of jobs in services and the preponderance of high technology firms.

V. METHODOLOGICAL ISSUES

This research aims to understand how technological change has affected the labor market in Mexico, especially for those jobs closely related to office work. To this end, the paper analyzes monthly data which were collected from the classified ads section of the Mexican newspaper *El Universal* from January 1980 to December 2012. Therefore, the corresponding archival work was carried out in the national newspaper and periodicals library of Mexico. The choice for *El Universal* for searching job offers was based on the fact that it has an enduring prestige as a reliable source for jobs ads. Moreover, its classified ads are organized in such a way that they allow us extracting very useful information, such as type of post, salary, years of experience and so forth. Data collected included information about total number of ads by month, as well as the salary offered by each one, if any. It is

worth mentioning that only aggregate job offers are analyzed in this paper.

The criterion for analyzing how technological change has affected the Mexican labor market stemmed from the very same characteristics of those occupations most likely to be affected. That is, popular office jobs that are acknowledged as archetypical clerical posts. Besides, clerical jobs have a good reputation in Mexico for their attractive wages and work stability. The most prominent jobs in this category are secretaries, messengers, typists and data analysts.

Therefore, the six occupations under scrutiny were data entry keyer (data typist), photographer, computer systems analyst, messenger and stenographer. In order to control for endogenous effects, these jobs were compared with monthly offers from a non-clerical employment. Thus, a manufacturing job was selected: lathe operator. The definitions and nature of these works are described next.

As shown above, the nature of the six jobs described will help us to understand how technological change has affected the availability of new posts in Mexico. The following section reports the empirical results from the research.

VI. EMPIRICAL FINDINGS

The analysis of monthly data from January 1980 to December 2012 produced 396 observations for each one of the six job categories under investigation. The analysis is primarily focused on detecting time trends in each category. Reports for each category are discussed next.

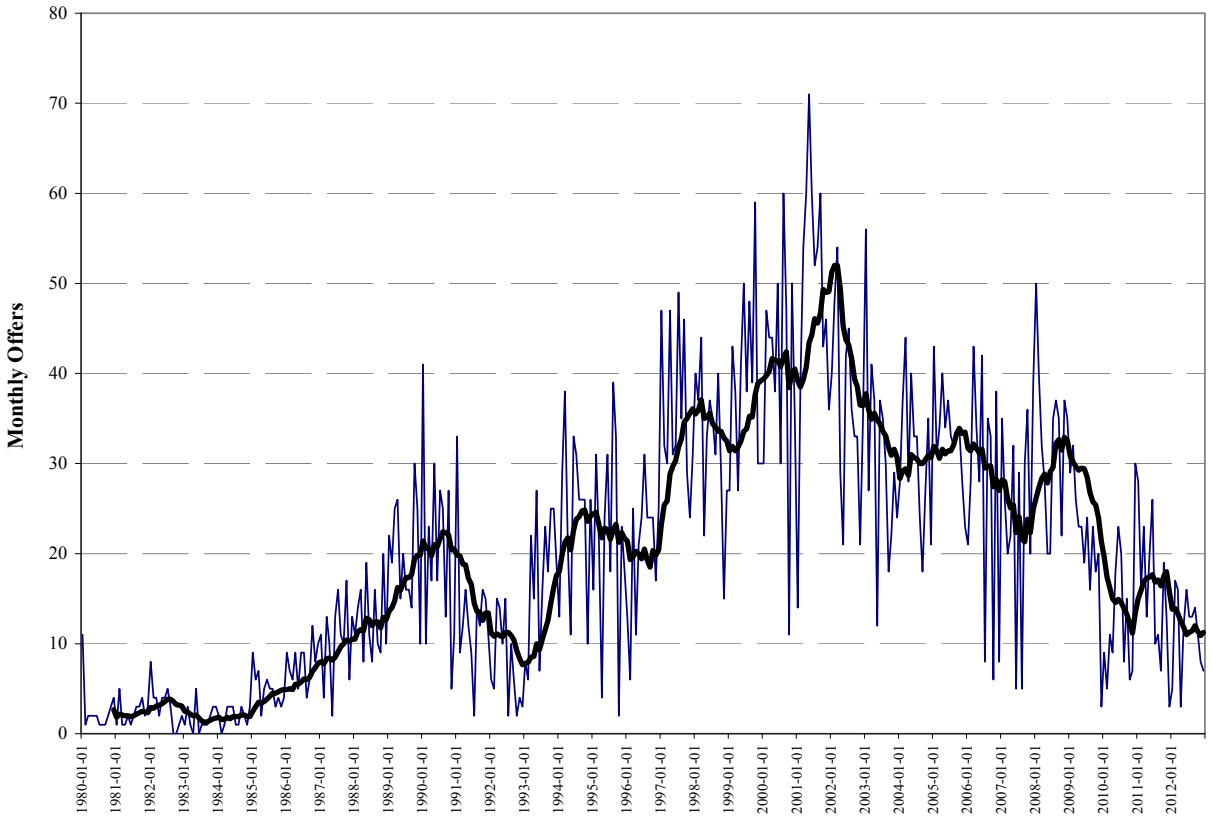
A. Data entry keyers (DEK)

Results from the empirical analysis suggest that DEKs are still demanded by the Mexican labor market, albeit in a lesser extent that before. The following graph clearly shows that offers for DEKs peaked in May 2001 in the period January 1980-December 2012.

TABLE 1: JOBS DESCRIPTIONS

JOB	DESCRIPTION
Data Entry Keyer (DEK)	Data entry keyers, also called data entry operators and key entry operators, enter lists of items, numbers, or other data into computers, where it is stored or used for research purposes. They often help to transfer information from checks, licenses, or other paper documents into a computer. Data entry keyers normally use data or number keypads to feed information directly into a computer. They must be fast and accurate. The material they work with is standardized, and they do not have to use their judgment to select or code the data. Data entry keyers may also be required to operate other equipment, such as printers or tape readers. However, most of the work data entry keyers do is repetitive.
Photographer (PHT)	Photographers use their technical expertise, creativity, and composition skills to produce and preserve images that visually tell a story or record an event. Their working conditions vary considerably depending on their specialty. Some travel for photoshoots; others work in their own studios. Still others work in laboratories and use microscopes to photograph subjects.
Computer Systems Analyst (CSA)	Computer systems analysts study an organization's current computer systems and procedures and design information systems solutions to help the organization operate more efficiently and effectively. They bring business and information technology together by understanding the needs and limitations of both.
Messenger (MSG)	An office messenger is responsible for safely transporting documents and small packages from one office to another, even of those offices are in different buildings on opposite sides of town. The nature of office messenger work has changed since fax machines and electronic mail have become common. Now that documents can be transmitted to the other side of the globe in the matter of seconds, it is not necessary to have an individual hand deliver hard copies of certain documents in many cases. There are, however, some documents that must be delivered in hard-copy form. This is especially true of documents that require signatures and legal documents. These kinds of documents are still sent via office messenger on a regular basis.
Stenographer (STN)	A stenographer is a trained professional whose work involves accurately transcribing verbal communications, such as trials or business meetings, in real time. Most stenographers learn a series of shorthand notations to make transcriptions more efficient. Stenographers also frequently find work in business settings. Law firms retain stenographers to record witness depositions and interviews that may have significance to a pending case. These meetings often happen in conference rooms or private offices.
Lathe Operator (LAO)	A lathe operator is responsible for the preparation and functioning of machinery that shape, bore, or cut a screw thread in a substance such as wood or metal, as well as the actual execution of them. The goal of the operator is to perform functions on workpieces that meet the appropriate criteria and specifications. The work environment of a lathe operator can be in a specialized tool production section of a factory or tool shop.

Sources: For Data Entry Keyers (DEK), http://careers.stateuniversity.com/pages/161/Data-Entry-Keyer.html. For Photographers (PHT): http://www.bls.gov/ooh/media-and-communication/photographers.htm. For Computer Systems Analysts (CSA): http://www.bls.gov/ooh/computer-and-information-technology/computer-systems-analysts.htm. For Messengers (MSG): http://www.wisegeek.com/what-does-an-office-messenger-do.htm. For Stenographers (STN): http://www.wisegeek.org/what-is-a-stenographer.htm. For Lathe Operators (LAO): http://www.wisegeek.com/what-does-a-lathe-operator-do.htm. [Data retrieved on January 15, 2014].



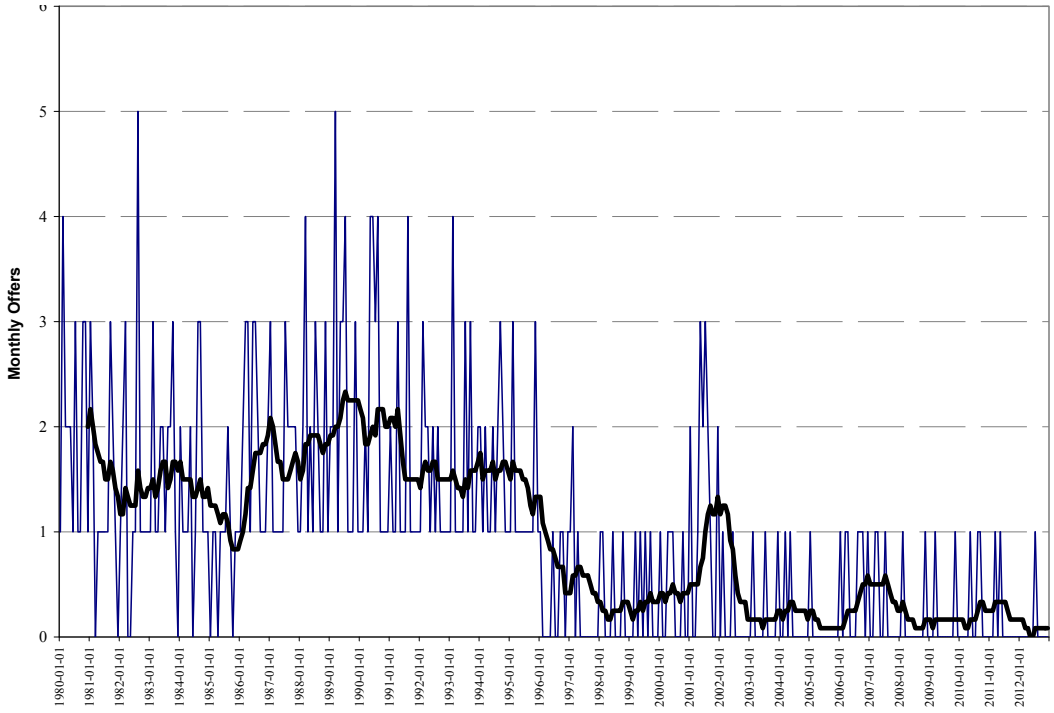
Notes: The blue thin line reports monthly data. The gross black line describes the 12-month moving average.
Source: Author's research based on data collected from the Mexican newspaper *El Universal*
Fig. 1: Monthly job offers for data entry keyers in Mexico City, 1980-2012

As shown above, the demand for DEKs started to rise in 1984, reached an initial crest in 1990 and then began to decline to reach its lowest value in 1993. From that year on, it got a zigzagging climb in its way to reach its highest average value during 2001-2002. From that year on, it has followed a descending trend that suggests a weak, but still existing, demand for this kind of jobs. One possible explanation for the declining trend showed from 2002 onwards is that data entry for computers has become more user-friendly, so the hiring of specialists to carry out this work is no longer as necessary as it used to be.

B. Photographers (PHT)

Results from the empirical analysis suggest that a PHT is the less required job in this subset of occupations. Fig. 2 shows how PHT offers behaved between January 1980 and December 2012.

In fig. 2, one can observe that job offers for photographers have always been very limited in Mexico. The highest number of offers was reached twice: in 1982 and 1989, with only five posts in bid. Nonetheless, the demand for photographers seemed to start to slowly decline from that year on, with 1996 showing a notorious declining trend. Since that year the number of months with zero offers began to multiply. This phenomenon hints at the fact that the introduction of digital cameras may have somewhat affected the demand for this kind of specialized occupation.

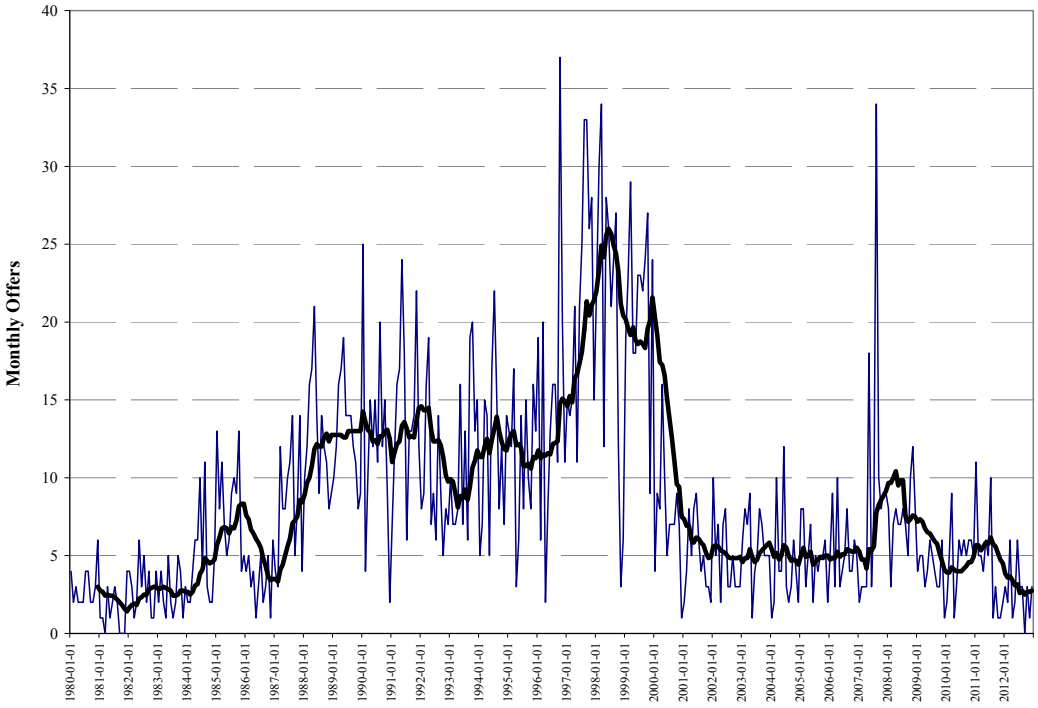


Notes: The blue thin line reports monthly data. The gross black line describes the 12-month moving average.
Source: Author's research based on data collected from the Mexican newspaper *El Universal*

Fig. 2: Monthly job offers for photographers in Mexico City, 1980-2012

C. Computer systems analysts (CSA)

Results from the empirical analysis suggest that CSA used to be a fashionable job during the 1990s, and then losing its appeal at the beginning of the new century. The following figure shows how job offers for this category behaved between January 1980 and December 2012.



Notes: The blue thin line reports monthly data. The gross black line describes the 12-month moving average.
Source: Author's research based on data collected from the Mexican newspaper *El Universal*

Fig. 3: Monthly job offers for computer systems analysts in Mexico City, 1980-2012

The trend showed in the figure above, suggests the existence of two big phases for CSAs seeking jobs in Mexico. In the early 1980s, job demand was modest but it started to rise in 1987. From that year on, offers followed an increasing path, reaching an absolute peak in 1998 and, quite surprisingly, drastically plummeted from 1998 to 2001, and thus reaching a plateau at around five offers by month since then. The stabilization of this trend suggests that the market has somewhat become stagnant, although the 2007-2008 surge seems out of context given the weak economic conditions that prevailed in the Mexico during those years.

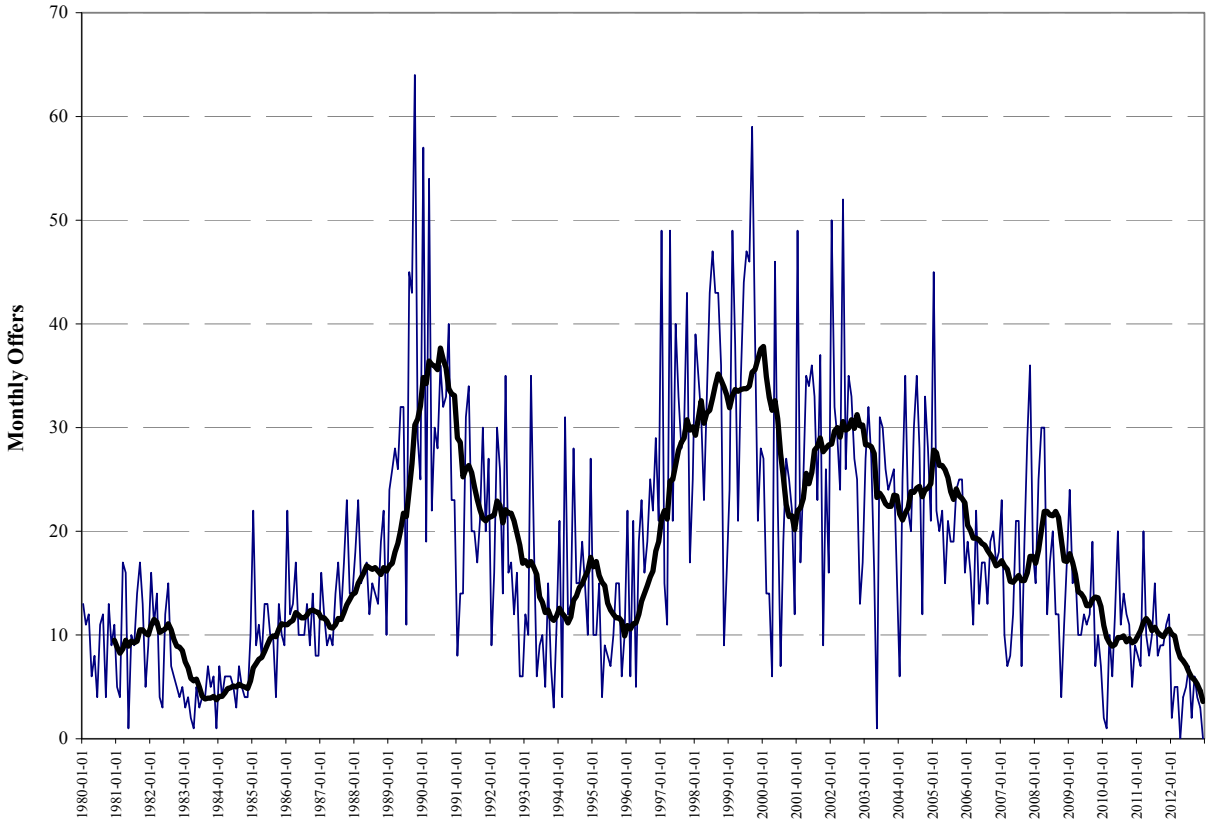
D. Messengers (MSG)

Results from the empirical analysis suggest that the labor market for messengers experienced several booms and busts during the 1980-2012 period. In order to grasp the specific times of these fluctuations, Fig. 4 shows how job offers for MSGs behaved between 1980 and 2012.

The market for messengers in Mexico has exhibited a winding path. Ups and downs seemed to be the norm from the whole period under research. Two notorious peaks can be observed, however. The first occurred between 1989 and 1990 and the second occurred at the end of the 1990s. a possible explanation is that, given its physical work nature (i.e., the mobility of tangible documents), messengers seemed more susceptible to the effects of business cycles than to the impact of the introduction of new technologies. Nonetheless, work offers have steadily been declining since 2003, suggesting that technical change had finally made its mark on this job.

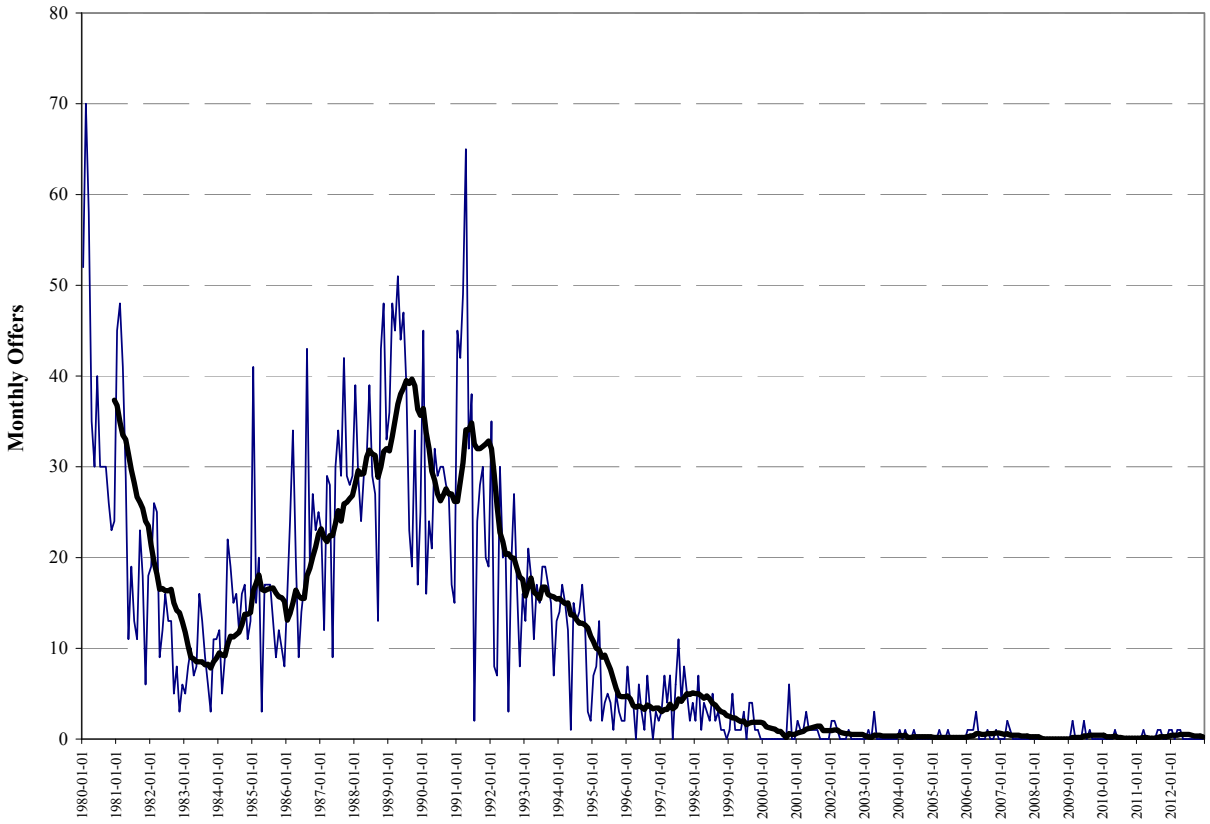
E. Stenographers (STN)

Results from the empirical analysis suggest that stenographers in Mexico have already become extinct in labor market terms. Fig. 5 shows how job offers for STNs behaved from 1980 to 2012.



Notes: The blue thin line reports monthly data. The gross black line describes the 12-month moving average.
Source: Author's research based on data collected from the Mexican newspaper *El Universal*

Fig. 4: Monthly job offers for messengers in Mexico City, 1980-2012



Notes: The blue thin line reports monthly data. The gross black line describes the 12-month moving average.
Source: Author's research based on data collected from the Mexican newspaper *El Universal*

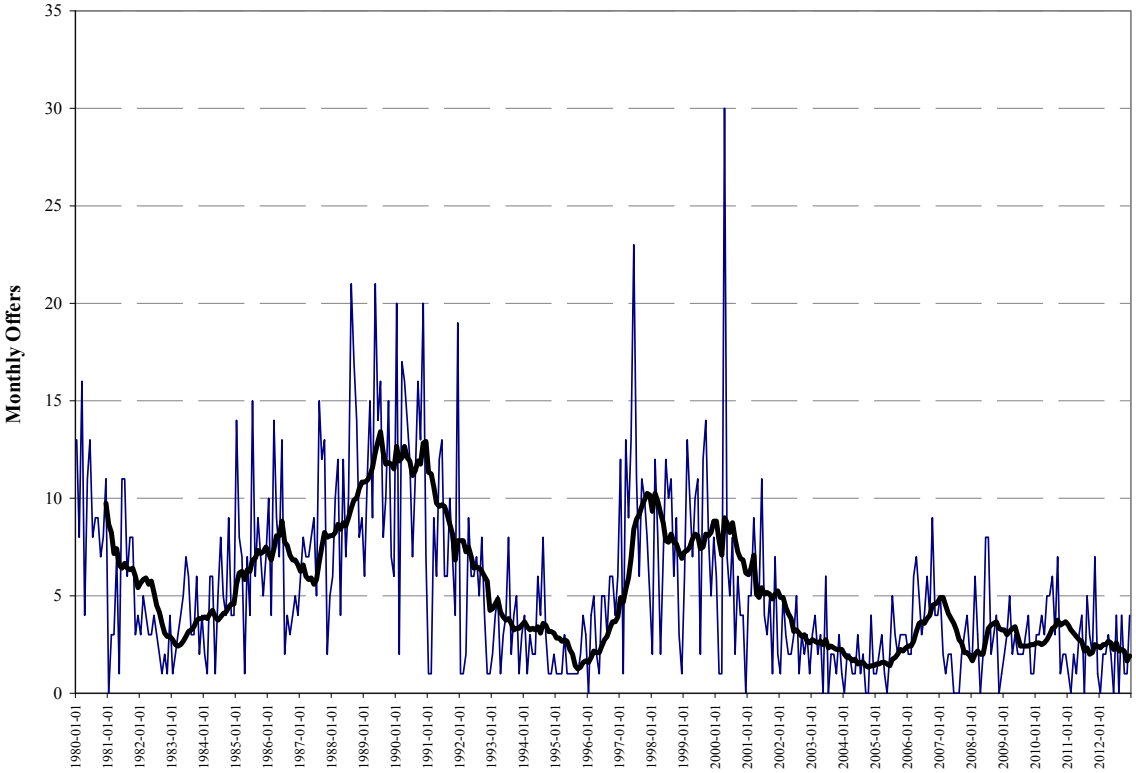
Fig. 5: Monthly job offers for stenographers in Mexico City, 1980-2012

From Fig. 5, above, one can clearly observe how technological change seems to have had a direct and visible effect in the number of job offers published for STNs in Mexico. From their two highest peaks in February 1980 and April 1994, offers started a long decline from the later year up to 2002 when they practically disappeared. The graph shows that a declining trend was already happening in the early 1980s just to bottom out in 1983, when it suddenly started to recover, and thus reaching the early 1990s peak. Later on, the path to extinction happened. Clearly, this occupation epitomizes the typical clerical job endangered by the introduction of new technologies in the office. As it is happening in many countries that used to heavily rely on paper work to sort out their intricate legal system, the role played by STNs became irrelevant as soon as their skills were superseded by the introduction of smarter technologies. Fortunately, the demise of the stenographer took such a long time as to allow them to re-training.

F. Lathe operators (LAO)

We need to bear in mind that this job category was introduced to control for the effect of technical change in the office. Results from the empirical analysis suggest that this job has faced a steady demand in Mexico. In order to depict this situation, Fig. 6 shows how job offers for this category behaved between January 1980 and December 2012.

As shown below, the demand for LAOs has followed a wavy tendency, experiencing two relative peaks: from 1988 to 1991, and then from 1997 to 2001, which coincided with Mexico's economic growth. From the later year on, it has followed a downward zigzagging trend, though. One possible explanation for this is that lathe operators depend on favorable economic conditions to find jobs; so economic booms, such as those described here tend to push job offers, whereas stagnant economic conditions deter manufacturing firms for seeking such specialized workers.



Notes: The blue thin line reports monthly data. The gross black line describes the 12-month moving average.
Source: Author's research based on data collected from the Mexican newspaper *El Universal*
Fig. 6: Monthly job offers for lathe operators in Mexico City, 1980-2012

TABLE 2: MATRIX CORRELATION FOR SIX JOBS, 1980-2012

Posts	PHT	CSA	MSG	STN	LAO
DEK	-0.266 **	0.338 **	0.586 **	-0.402 **	-0.005
PHT		0.032	-0.036	0.585 **	0.284 **
CSA			0.488 **	0.093	0.369 **
MSG				-0.024	0.328 **
STN					0.459 **

Notes: Pearson Correlation; No. of observations: 396; (**) Correlation is significant at the 0.01 level (2-tailed)
Source: Author's calculations based on archival data

G. Statistical analysis on annual trends for the six categories

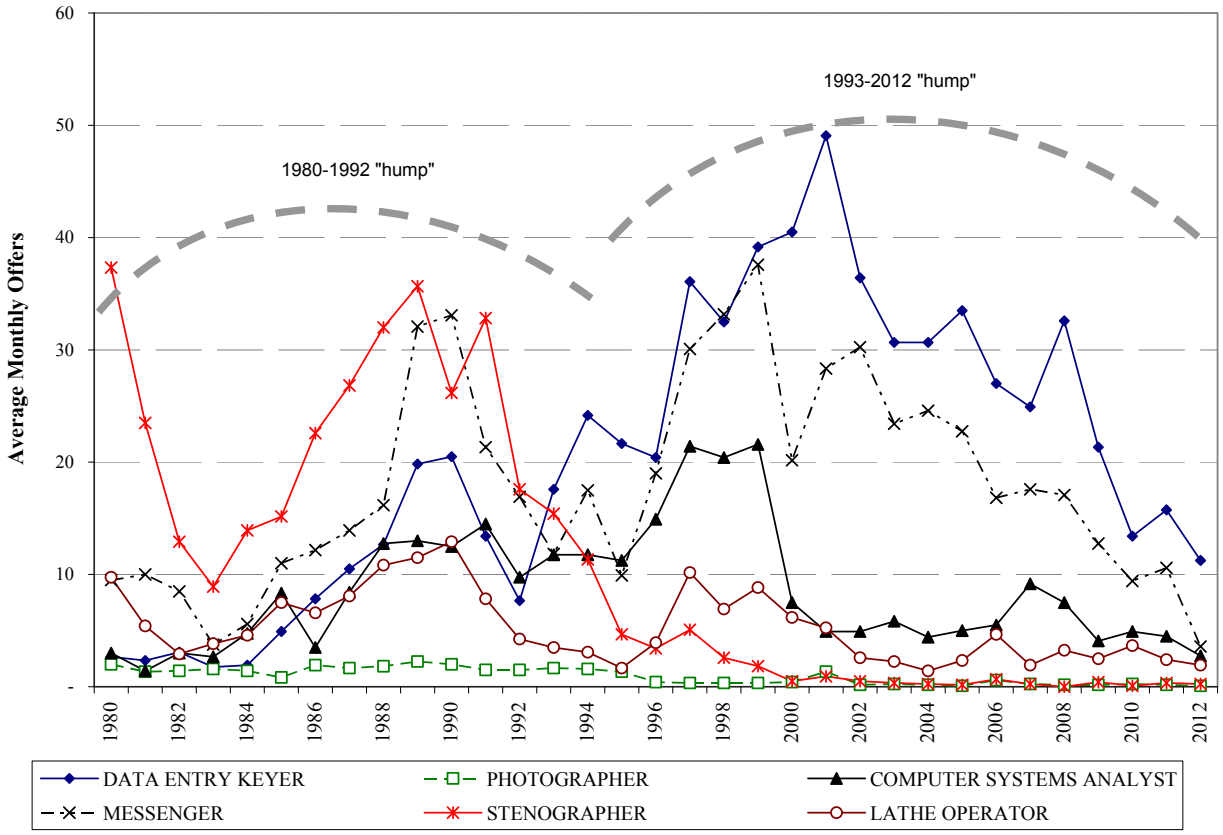
When grouped together, the six categories produce a rather messy graph. Although it may help us to visualize the overall impact of technological change on the Mexican job market, its interpretation is not easy. We then need to pursue a more accurate analysis. The following table depicts the correlation matrix for all six posts during the 396 months encompassed in the 1980-2012 period.

According to the data showed above, two pairs of jobs seemed to be highly correlated during the 1980-2012 period: data entry keyers and messengers, on the one hand, and photographers and stenographers, on the other hand, with the pair DEK-MSG having the stronger correlation only slightly above from that of the PHT-STN pair.

That means that jobs offers for these two pairs were highly correlated throughout the 1980-2012 period. Yet, DEKs and PHTs were apparently inversely related during this period, as in the case of the STN-MSG pair.

Thus, the analysis discovers an existing highly significant inverse correlation between data entry keyers and stenographers. One can infer a possible substitution between the two categories, with the stenographers losing ground in favor of DEKs.

Moreover, when all the categories are reduced to their annual averages—in order to simplify the graphing—and put together, it is possible to distinguish two big cycles (or humps) in the period under analysis. The first hump roughly covers the 1980-1992 period, and the second the 1993-2012. The figure below shows the annual average offers for the six categories.



Notes: The blue thin line reports monthly data. The gross black line describes the 12-month moving average.
Source: Author's research based on data collected from the Mexican newspaper *El Universal*

Fig. 7: Annual average job offers for all categories, 1980-2012

A possible interpretation of the first phase is that the work based on old skills enjoyed a sort of golden period just before the arrival of ICTs when their abilities became useless. This time corresponds to the first cycle (1980-1992), when stenographers and messengers experienced a surge in job offers. As regards the second cycle (1993-2012), old skills clearly gave way to the new ones, possibly as a result of the rapid penetration of ICTs. So, this explains the rise in job offers for data entry keyers and computer systems analysts during the period. Finally, in the case of photographers and lathe operators, the figure clearly shows that they had the lowest level of job offers in the two cycles, and thus their chances of finding a job may have been affected by the introduction of the new technologies but only marginally, as their skills seemed to be not too much required anyway.

In this respect it is worth noting that classified ads themselves could have been affected by the penetration of ICTs as well, as employers found easier (and cheaper) to advertise their offers by alternative electronic means, such as the specialized network LinkedIn, for example. This situation may explain the overall decline in job offers for all the categories from 2008 onwards. If that would be the case, further studies on analyzing how technological change has affected employment ads should consider the use of newer electronic sources instead of the old-fashioned newspaper to track these changes.

VII. CONCLUSIONS

The advent of information and communications technologies has altered many productive activities. The phenomenon has been felt all around the world with different consequences. In developed countries computerization has been widespread and keeps on transforming job routines and organizational processes. In developing nations, their presence is far less evident but keeps on advancing. Consequently, public opinion has begun to show a growing interest in the subject. Among the chief concerns that people express regarding technological change are those related to its impact on productive jobs.

However, the impact of technological change on employment is neither easy to understand, nor to estimate because technological changes do not affect all workers the same way. Some find that their skills are complementary to new technologies. Others find themselves out of work. Yet, technological change improves productivity by optimizing production processes. Moreover, by raising productivity, any automation which economizes on the use of labor tends to

increase personal income. That will generate demand for new products and services, which will in turn create new jobs for displaced workers. Nonetheless, it remains important to bear in mind that those workers who lose their jobs through the substitution of automated processes for older, and more labor-intensive, techniques may very well adopt a "Luddite" attitude towards process innovations in their own sector.

In the case of office jobs, the introduction of new technologies have altered the traditional structure of tasks, and thus of the skills needed to perform them. For example, jobs linked with the handling of tangible objects such as letters and folders are becoming less necessary as most documents are being translated into the digital realm. Hence, white-collar workers have been pushed to transform themselves from "physical workers" to "knowledge workers" as new duties have appeared and new computer skills are required.

In Mexico, the impact of technological change on clerical employment is just being acknowledged, although it has not been an easy process. On the one hand, the lack of competitive conditions in the telecommunications sector has deterred investors from entering the market and thus limiting the choices for the consumer. On the other hand, low wages have delayed the adoption of labor-substituting technologies.

Taking all these factors together, one finds that Mexico shows a contrasting picture in technological terms. There are a handful of large firms, mostly foreign-owned affiliates, having state-of-the-art machines and highly skilled personnel to operate them, while the large majority of businesses are small, family-owned, operate obsolete machines and employ many workers that master basic technological capabilities only. These contrasts explain the co-existence of low-skilled and high-skilled workers into the same sectors. In this regard, the analysis carried out in this paper shows that only stenographers have no chance of finding a job in Mexico because their abilities are not longer necessary. This fact suggests that it may take more time in Mexico to adopt world-class technologies in offices than in the rest of the OECD area. But even the supposedly high-skilled jobs in the analysis were not as demanded as expected. Data entry keyers and computer systems analysts experienced a temporary boom in the early 2000 just to decline afterwards. This suggests that technological change may have had an effect after all, but on how job offers are now advertised. In the early ages of the ICT revolution, newspapers were both practical and useful to disseminate information but as the new technology proceeded, it also took over the print media, so probably classified ads are moving to the cyberspace too, and the possibilities of finding a job now also depend on the digital literacy of would-be employees.

Because a new productive paradigm is rising, in which automation is rendering old skills useless, there is an increasing need for understanding how technological change is transforming employment, therefore. And even if a nation's workforce is highly qualified by today's standards, it might not be tomorrow; so, productive firms need to rethink how they manage human capital. Then if the Mexican economy is to remain competitive, it needs talented people. But it also needs the right skills and, as this study has shown, it has to provide the possibilities to re-train those who had lost their jobs and still want to catch up with the technological changes.

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