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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.

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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].

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.

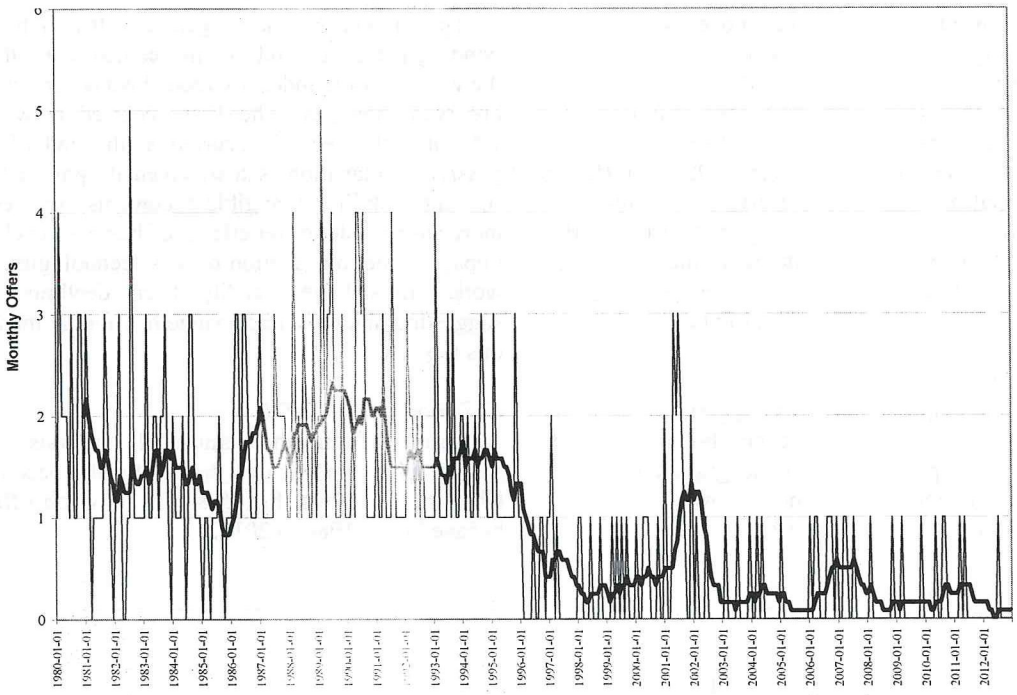
A. Data entry keyers (DEK)

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.

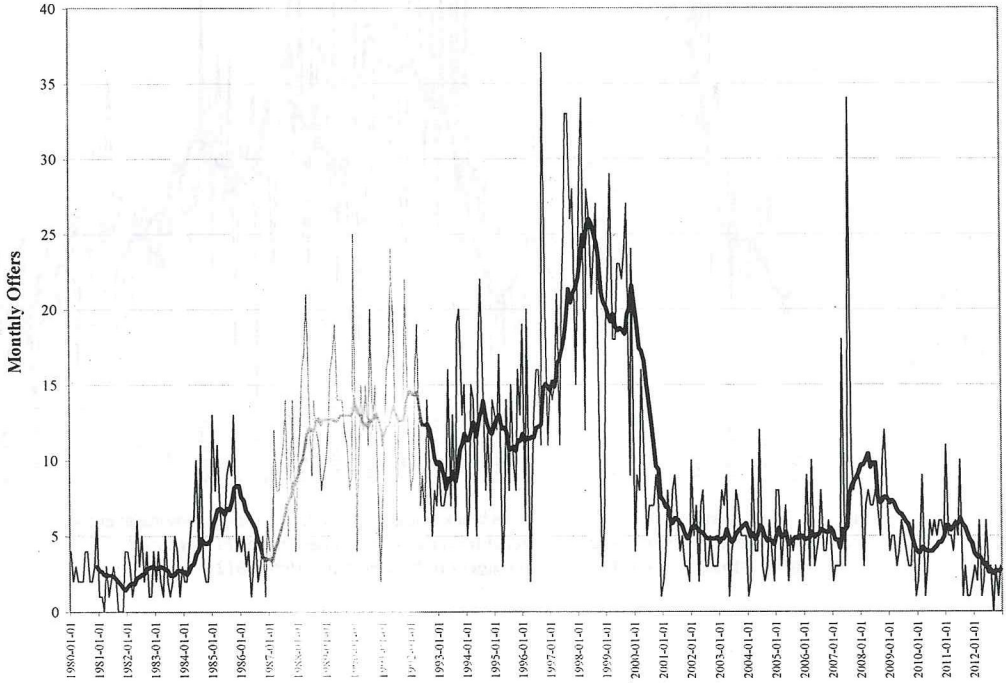
Sources: For Data Entry Keyers (DEK), http://careers.stateuniversity.com/pages/161/Data-Entry-Keyer.html. For Photographers (PHT): http://www.bls.gov/ooh/media-and-communication/photographers.htm. For Computer Systems Analysts (CSA): http://www.bls.gov/ooh/computer-and-information-technology/computer-systems-analysts.htm. 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].



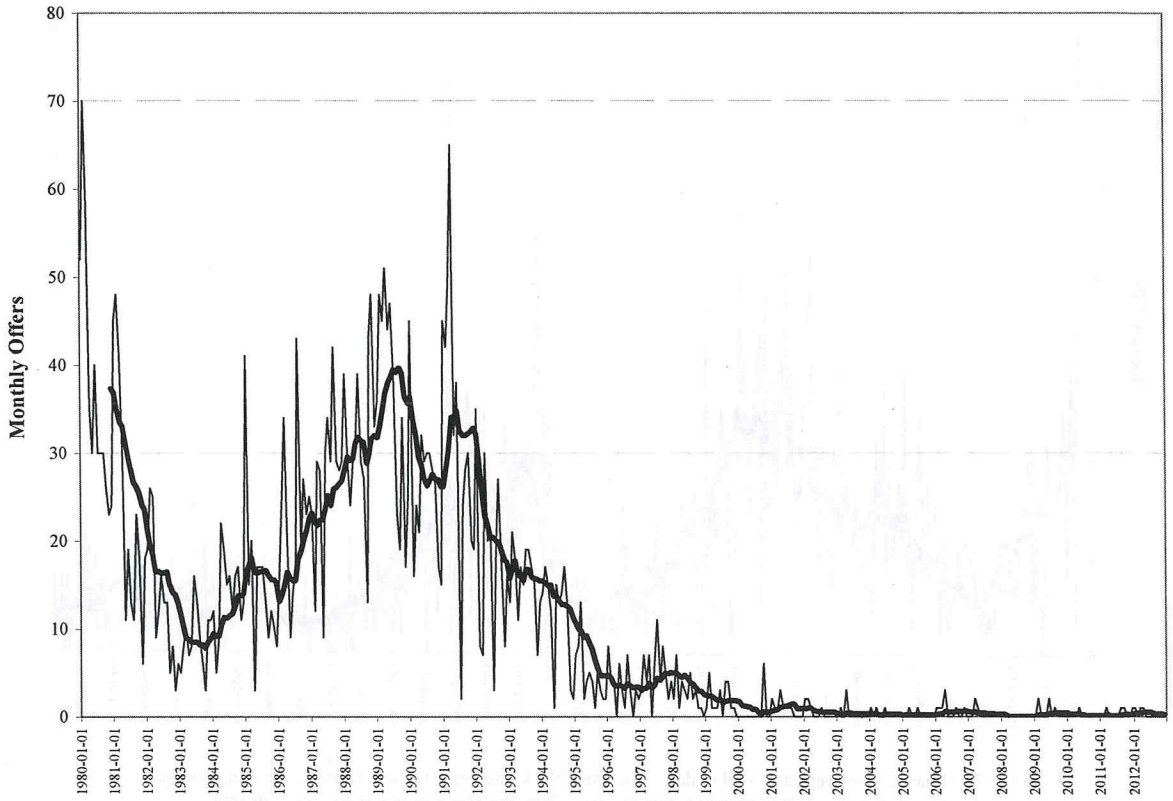
Notes: The blue thin line reports monthly data. The gross black line describes the 12-month moving average.
Source: Author's research based on data collected from the Mexican newspaper *El Universal*
Fig. 2: Monthly job offers for photographers in Mexico City, 1980-2012

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



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*

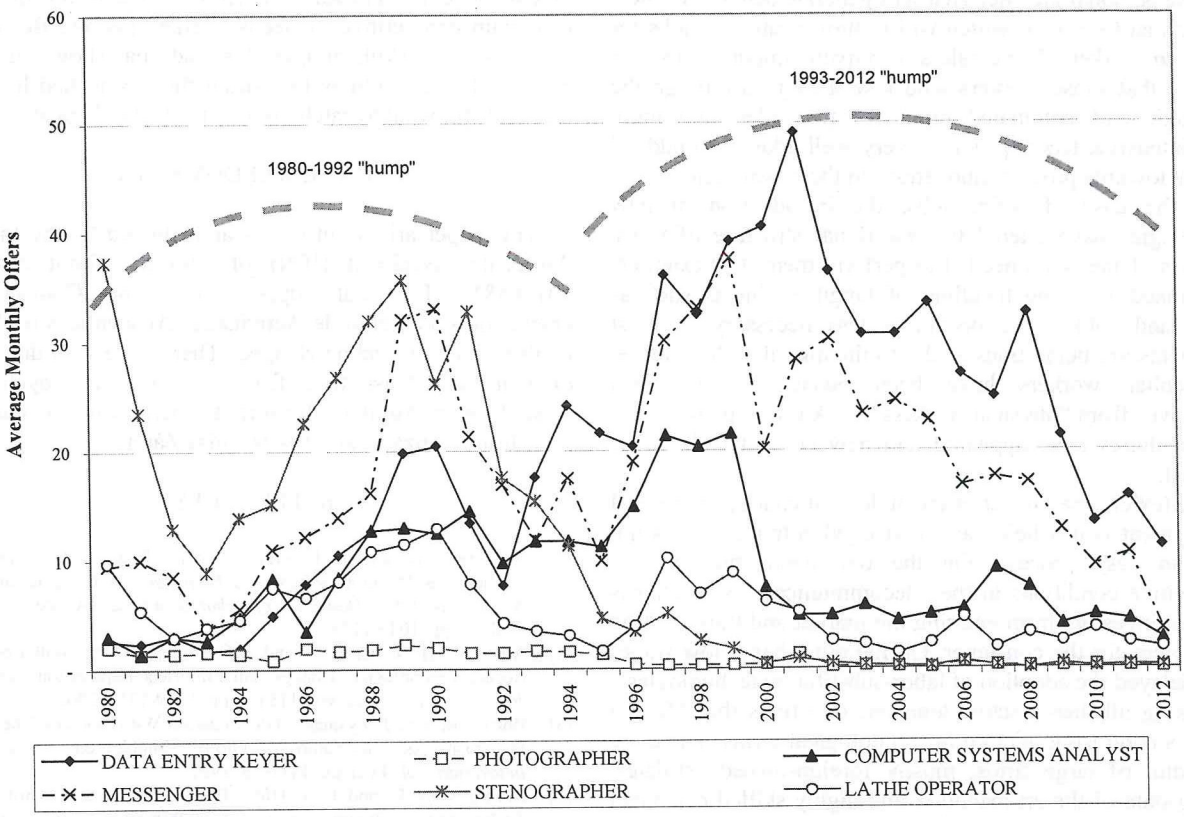
Fig. 5: Monthly job offers for stenographers in Mexico City, 1980-2012

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. 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

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