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# NEW WORK: OLD BARRIERS BUT NEW OPPORTUNITIES FOR WOMEN

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# NEW WORK: OLD BARRIERS BUT NEW OPPORTUNITIES FOR WOMEN[1]

**ABSTRACT:**
Many studies have pointed out that the dissemination of new information and communication technologies (ICTs) is leading to profound changes in economic activity and employment. The dissemination and large-scale use of ICTs has led to an increase in the rate of organisational and technological innovation, the development of knowledge-intensive services, and higher qualification requirements for many sectors of the employed population.
There are also signs that this new labour context may offer new opportunities for women. Several studies have considered the relative advantage of women in terms of their level of education and labour flexibility, and the emergence of greater possibilities for achieving work-life balance.
Based on the literature on this subject, this paper pursues two objectives. Firstly, it makes a comparative analysis for the EU based on an exhaustive review of the most important statistical sources. It determines the extent to which the dissemination of ICTs is associated with a greater presence of women. The conclusion is positive, though inequalities in working conditions do persist. Secondly, it makes a specific analysis for Spain, identifying the reasons why these activities favour the position of women in employment. It applies shift-share techniques to a battery of variables associated with female employment. It concludes that employment in ICTs, beyond the fact that its composition is particularly favourable to certain characteristics of female employment, and shows some trends that are conducive to greater feminisation.
**KEY WORDS**: Female employment / gender equality / information and communication technologies / knowledge-based society

**RESUMEN:**
Son varios los estudios que han señalado que la difusión de las nuevas tecnologías de la información y la comunicación (TIC) está introduciendo cambios profundos en la actividad económica y el empleo. La difusión y generalización del uso de las TIC se relaciona con un incremento en el ratio de innovación organizativa y tecnológica, el desarrollo de los servicios intensivos en conocimiento y el requerimiento de elevadas cualificaciones para amplios sectores de la población empleada.
Hay también señales de que este nuevo contexto laboral ofrece nuevas oportunidades para las mujeres. Varios estudios han considerado la ventaja relativa de las mujeres en términos de su nivel de educación y flexibilidad laboral, así como la emergencia de mayores posibilidades de alcanzar un equilibrio entre trabajo y vida familiar.
Sobre la base de la literatura existente a este respecto, este trabajo se propone dos objetivos. En primer lugar, llevar a cabo un análisis comparativo para los países de la UE a partir de una revisión exhaustiva de las fuentes estadísticas más importantes, como forma de determinar la intensidad con que la difusión de las TICs se asocia con una mayor presencia de la mujer. La conclusión que se obtiene es positiva, a pesar de que persisten desigualdades en las condiciones laborales. En segundo lugar, se lleva a cabo un análisis específico para España, identificando las razones por las que estas actividades favorecen la posición de la mujer en el empleo. Para ello se aplican técnicas shiftt-share a una batería de variables asociadas con el empleo femenino. Se concluye que el empleo en TICs, más allá del hecho de que su composición es favorable a ciertas características del empleo femenino, muestra algunas tendencias explicativas de su mayor feminización.
**PALABRAS CLAVE**: empleo femenino, igualdad de género, tecnologías de la información y la comunicación, sociedad basada en el conocimiento.

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## INDEX

## 1. THEORETICAL FRAMEWORK

The impact of the dissemination of information and communication technologies (ICTs) on employment and work has been analysed from two main perspectives. The economic perspective focuses on its effects on enhancing productivity and economic growth and the changes in labour institutions needed to achieve those benefits. The labour and social perspective deals with the new characteristics and increased education requirements of jobs, new skills and abilities, the changes in the structure of occupations and the new types of flexible working arrangements.

The erosion of the traditional mass production system based on hierarchical organizations, low-educated manpower and standard working conditions has given rise to an interesting debate: will it bring about a new system of production ad organization or will the old structures persist?

The rigidity of the former system of technology, work organization and work arrangements made it very difficult for companies to adapt to rapid changes in market demands (see, among others, Arbernarthy, 1978; Dertouzos, 1992 and Coriat 1994). Different approaches to flexibility were adopted in an environment characterized by shorter product life-cycles. The new paradigm of production and organization, based on the increasing importance of knowledge and information, brought a drastic change in the content of many jobs. Among other features of the new system, a highly educated labour force is needed and a gradual process of individualization of the working conditions is underway. Contractual, spatial and functional flexibility give rise to concern about the effects of the new working environment for workers (Gallie, 2002; Webster, 2002; Serrano and Mosesdottir, 2005).

The spread of ICTs, along with innovations in organization, played an important role in enhancing flexibility and changing the shape of the labour market. In the 1980s, research confirmed that the main effects of ICTs on employment and work were not mainly related to the final balance between creating and destroying jobs but to structural changes in employment (Leontieff and Duchin, 1985; Kaplinsky, 1989; Sylvestry, 1983; Kern and Schumann, 1988). Many traditional low-skilled jobs were shifted or replaced by technological applications, especially in traditional industries. The new and more technologically advanced sectors created new skilled jobs whilst the service sectors created many new unskilled jobs.

The rise of the knowledge-based society (KBS) focused the debate in the 1990s on the changes in the structure of occupations and the new education and skill requirements of jobs (Arnal et al, 2000; Appelbaum and Albin, 1990; Carnoy, 2000; Collechia and Papaconstantinou, 1996; MacDonald and Siriany, 1996; Soete, 2001; Thompson and Warhurst,

1998; Wolf and Baumol, 1989). Knowledge-intensive employment, education and skills appeared as a new research topic after the debate on deskilling and loss of qualifications launched by Braverman's *Labor and Monopoly Capital* (1974) had been overcome.

As knowledge has become a key element for economic growth and social wellbeing, the demand for workers who generate ideas and knowledge has risen. High-skilled labour and new technology seem to be complementary (Arnal, Wooseok and Torres, 2001). What is needed is not just advanced technologies and flexible organization structures, but also highly educated, autonomous and talented people who have education and experience in specific areas of knowledge in addition to communication and interpersonal skills (*soft skills*, like verbal communication, team working, commitment to problem solving, the ability to learn quickly, creativity and innovation).

Knowledge and flexibility are thus key components of the following changes in employment and work related to the spread of ICTs:

1. The boundaries of the working place and working time have become blurred. Teleworking, networking and working any day or night time are a main feature of today's jobs (Webster, 2000; ECATT, 2000; Valenduc and Vendramin, 2001)

2. New job tasks involve an increasing degree of autonomy, but also responsibility, for each worker. New working practices seem to erase old hierarchies but in fact erode collective bargaining (Ducatel and Burgleman, 1999; Gareis, 2002; Sennent, 2000; Osterman, 2000).

3. Skills are not just defined in terms of manual or technical expertise, as was typical of old professions. Today they are made up of knowledge, communication and team-working abilities. The old professional categories, regulated by collective agreements, are replaced by *competencies* that are specific to each person (WWW.ICT, 2004; Gareis, 2001).

4. Information-related jobs are not necessarily stable or permanent ones. In spite of the education and skill requirements, the rapid evolution of ICTs shortens the skills' lifecycle and makes permanent training essential. Education and training in these fields are, nevertheless, expensive and time-consuming. Very often hiring young fresh graduates is less costly than retraining older workers (Ducatel and Burgleman, 2000). Subcontracting and offshoring are alternatives for reducing labour costs (Benería, 2001).

5. Temporary (fixed-term) contracts and part-time arrangements, along with all the new features of the working environment mentioned above, mean that human resources are used just *when, how* and *where* they are needed. The principles of *just-in-*

*time* and *lean production* systems are ultimately applied to human resources management.

Wolf and Baumol (1989) emphasize the difference between *information-related* occupations and *non-information-related* occupations. The first category includes knowledge workers (the ones who generate ideas) and data workers (the ones who manipulate information). The second includes goods production workers and personal service workers. In the 1990s knowledge workers were the occupational category with the highest increase (3.3% versus 2.2% for service workers, 0.9% for data workers and -0.2% for goods production workers) in the main OECD countries (EU-15 and US, Arnal et al., 2001).

The demand for highly skilled workers (university graduates) is increasing. In the EU-25 *high-skilled non-manual* occupations (ISCO 88 levels 1-3) represented 39% of employment in 2005. Among women the percentage is higher (40.0% versus 38.8% for men). This is especially the case in Spain, with 34.2% of women employed in these occupations, compared to just 28.7% of men (Johuette and Romans, 2006). The increasing number of women with university degrees entering the labour market (Golding, 2006; Castaño, Iglesias, Mañas, Sánchez Herrero, 1999; Castells, 1997) provides the consistent reserve of educated and flexible workers that the knowledge-based society requires.

Women also have a higher percentage of part-time and temporary contracts than men. In all EU-25 member states, the proportion of employees with temporary contracts is between 1 and 2 percentage points higher for women than for men, though the figures vary markedly between countries. Temporary working is particularly important in Spain, where 34% of women are employed on fixed-term contracts, compared with 30% of men. In the EU-25 part-time work represents 32.6% of female employment and just 7.5% of male employment, whereas in Spain the figures are 25.8 and 4.8%, respectively (Romans and Harsdarson, 2006).

Among other authors, Carnoy (2000) points out that along with the increase in self-employment, temporary and part time jobs, subcontracting and consulting, the *organization man* is declining while the *flexible woman* is on the rise. As stated by Blossfield and Drobnič (2001), the increase in female employment appears to have a dual nature: overall, there is some evidence of a declining occupational segregation in the full-time workforce, mainly driven by the rising number of 'gender mixed' semi-skilled and skilled occupations in the service economy; however, this trend is counterbalanced by an increasing occupational segregation in the part-time workforce in dead-end, low-skilled service jobs.

Here two questions arise. Firstly, can the massive entrance of women into the labour market be considered as necessary to (or a result of) the development of the knowledge-based society? The other big reserves of

*talent* (university degrees) for developed countries are immigration and off-shoring. Secondly, is the massive access of women to knowledge-intensive jobs a sign of an improvement in their position in the labour market or just the continuation of previous employment trends? The equalisation of educational attainments, combined with a shift in occupational structure (the rise in skilled service and administrative occupations) should make the earnings capacity of women and men increasingly similar across cohorts. However, empirical evidence reveals the persistence of gender pay gaps at all educational levels due, among other reasons, to occupational segregation and career breaks (Blossfield and Drobnič 2001; Stier et al. 2001).

Many studies and research projects have considered the barriers which women come up against in employment related to high-technology (Valenduc 2000; Webster et al. 2002; Stewart, 2002; Sorensen, 2002; Valenduc and Vendramin, 2003; Mosesdottir and Serrano, 2006; Castaño, 2005). In a world in which the economy is becoming dematerialized and services are provided through intermediate technology, the importance of educational requirements and intellectual and communicative capacity might help an increasing number of women who are better qualified to access those sectors most related to advanced technology, information and knowledge. However, the sectors which produce cutting-edge technology remain male reserves. As shown in Table 1, women account for more than 50% of university graduates in Europe, but women and men still follow different educational patterns: science and engineering remain male-dominated fields of study, with only around 30% of female graduates. In a similar line, the percentage of women among the skilled workforce in high-technology sectors is even lower (between 22 and 26% for the EU-25), although they are a large majority among professionals and technicians in other knowledge-intensive sectors. Finally, the gender pay gap in high-technology sectors is similar to the gap in other manufacturing and services sectors. Only in medium to high-technology manufacturing sectors (the least technology-intensive) does it seem to be substantially lower.

There are concerns about whether the organization and working conditions in high-technology manufacturing and service sectors (with interminable working days in which work invades the private sphere) might become a barrier to women. If the model taken is the young male professional with no family or domestic responsibilities and totally dedicated to his work, all the women who do not fit into this model are at a clear disadvantage. The flexibility that women demand to be able to reconcile the double workload of job and family could have serious consequences. Although female employment is growing because the flexible woman is on the increase, women will remain concentrated in a few knowledge-intensive services. The conclusion will be devastating: women are making some advances because of the increase in employment in qualified services, but segregation persists. The question here is whether the demand for knowledge and flexibility is challenging the present gender positions in the labour market or merely reinforcing

the previous segregation patterns, whether women are increasingly accessing traditional male jobs, or the changes and improvements in their position in the labour market are merely due to the increase in employment in the *female sectors and occupations*.

Table 1.
**Indicators on gender and the knowledge-based society. EU25 and selected countries**

| Share of women among graduates in tertiary education, by field of study (1999-2004) | | | | |
|---|---|---|---|---|
| | as a % of total graduates | | as a % of graduates in science and engineering | |
| | **1999** | **2004** | **1999** | **2004** |
| EU25 | 56.1 | 58.7 | 29.5 | 30.8 |
| EU15 | 54.9 | 57.1 | 29.1 | 30.5 |
| Denmark | 58.5 | 58.8 | 32.0 | 32.3 |
| Germany | 49.4 | 52.7 | 20.9 | 23.8 |
| Spain | 58.1 | 57.7 | 32.2 | 30.3 |
| Italy | 56.0 | 58.1 | 37.1 | 36.8 |
| United Kingdom | 54.6 | 57.7 | 29.6 | 31.2 |

| Share of women among professionals and technicians, by sector of activity (2005) | | | | | |
|---|---|---|---|---|---|
| | as a % of employment in manufacturing | | as a % of employment in services | | |
| | Total | High- and medium-high-technology manufacturing | Total | High-technology knowledge-intensive services | Other knowledge-intensive services |
| EU25 | 29 | 24 | 55 | 26 | 60 |
| EU15 | 27 | 22 | 53 | 25 | 59 |
| Denmark | 36 | 32 | 56 | 31 | 60 |
| Germany | 26 | 21 | 55 | 25 | 60 |
| Spain | 32 | 27 | 51 | 26 | 57 |
| Italy | 28 | 23 | 51 | 25 | 58 |
| United Kingdom | 27 | 22 | 52 | 19 | 57 |

| Women's annual earnings as % of men's, by sector of activity (2002) | | | | | |
|---|---|---|---|---|---|
| | Manufacturing | | | Services | |
| | Total manufacturing | High-technology manufacturing | Medium-high-technology manufacturing | Total services | High-technology knowledge-intensive services |
| Denmark | 79.5 | 69.8 | 81.7 | 76.3 | 76.9 |
| Germany | 72.3 | 66.2 | 78.4 | 72.9 | 72.2 |
| Spain | 72.9 | 71.5 | 80.4 | 71.8 | 72.5 |
| Italy | 78.9 | 74.0 | 83.2 | 78.8 | 92.0 |
| United Kingdom | 69.2 | 65.4 | 73.6 | 64.3 | 79.5 |

Source: Own calculations from Eurostat (2007)
Note: see the definition of science and engineering fields of study and sectors of activity in annex.

On the basis of this theoretical framework, the objective of this paper is to study the relations between gender, technology and knowledge in the Spanish case. This will involve three different steps. We will first study the distribution of employment by sector of activity, classified by its relation to technology and knowledge (Section 2). We will then ascertain whether the most technology- and knowledge-intensive sectors modify

the characteristics of employment (Section 3). Finally, we will determine whether technology and knowledge improve the labour position of woman, and attempt to offer some tentative explanations (Section 4). The data are from the Spanish Labour Force Survey (EPA) for the second quarters of 1996 and 2006.

## 2. THE SECTORAL STRUCTURE OF EMPLOYMENT IN RELATION TO TECHNOLOGY AND KNOWLEDGE

Table 2 shows the distribution of employment in Spain by sector of activity, classified on the basis of its relation to technology and knowledge[2]. Although the highest share of employment is in the less knowledge-intensive services (38.6%), 31.6% still work in activities related to technology and/or knowledge (T&K). Among these sectors, by far the highest proportion is in other knowledge-intensive services (O-KIS) (24.4%), though high-technology, knowledge-intensive services (HT-KIS) are growing rapidly.

Table 2.
**Distribution of employment by sectors of activity, classified on the basis of its relation with technology and knowledge. Spain (1996-2006)**

| Activity sectors | Absolute values (thousands) | | % | | Relat. var. |
|---|---|---|---|---|---|
| | 1996 | 2006 | 1996 | 2006 | |
| High-technology manufacturing (HT-M) | 66.64 | 85.69 | 0.5 | 0.4 | 28.6 |
| Medium-high-technology manufacturing (MHT-M) | 589.54 | 806.84 | 4.6 | 4.1 | 36.9 |
| Low- and medium-low technology manufacturing (LMLT-M) | 1,730.38 | 2,210.64 | 13.5 | 11.2 | 27.8 |
| High-technology knowledge-intensive services (HT-KIS) | 240.45 | 527.23 | 1.9 | 2.7 | 119.3 |
| Other knowledge-intensive services (O-KIS) | 2,775.45 | 4,798.09 | 21.7 | 24.4 | 72.9 |
| Less knowledge-intensive services (L-KIS) | 4,937.07 | 7,601.79 | 38.6 | 38.6 | 54.0 |
| Other activities (OA) | 2,450.48 | 3,662.82 | 19.2 | 18.6 | 49.5 |
| Total | 12,790.01 | 19,693.10 | 100.0 | 100.0 | 54.0 |
| Technology and knowledge employment (T&K) | 3,672.08 | 6,217.85 | 28.7 | 31.6 | 69.3 |
| Other employment (Rest) | 9,117.93 | 13,475.25 | 71.3 | 68.4 | 47.8 |
| Total | 12,790.01 | 19,693.10 | 100.0 | 100.0 | 54.0 |

Source: EPA. Second quarters.

The sectoral structure of employment in Spain is increasingly new-tech oriented. Employment related to T&K has increased its share of total employment by 4 points in the last decade. In this general trend we can observe that:

[2] The classification is based on Eurostat (2006). See the annex for further details.

1. The two service aggregations especially related to new technologies (HT-KIS and O-KIS) have increased their employment volume by a higher proportion than the aggregate (54%).

2. The growth in employment in HT-KIS has been especially intense (119%).

3. There has been a fall in the share of total employment of all manufacturing activities, regardless of their technological intensity, of services with a low relationship with knowledge, and of all other.

## 3. TECHNOLOGY, KNOWLEDGE AND CHARACTERISTICS OF EMPLOYMENT

The adoption of new technologies and the development of knowledge-intensive services can introduce important changes in the gender composition of employment, the type of skills required and the working conditions. In order to assess this in the case of Spain, we studied the incidence indexes for the sectors of activity most related to technology and knowledge (Table 3). Indexes were calculated for a wide range of personal and professional variables[3]. The aim of this analysis was to find the main characteristics of workers and workplaces in technology and/or knowledge activities[4].

[3] In addition to the variables included in the table, the incidence index was also calculated for the variables marital status, nationality and duration of the temporary contract. These results are not included because they do not introduce relevant differences.

[4] For each category the incidence index divides the frequency in each sectoral grouping by the frequency corresponding to the total employment. Thus, indexes higher than one indicate a greater presence of the characteristic in the sectoral grouping.

Table 3.
**Labour characteristics by sectors of activity, classified on the basis of its relation with technology and knowledge. Indexes of incidence. Spain (2006)**

| Characteristics | HT-M | MHT-M | HT-KIS | O-KIS |
|---|---|---|---|---|
| Sex | | | | |
| Men | 1.19 | 1.36 | 1.11 | 0.69 |
| Woman | 0.73 | 0.48 | 0.84 | 1.45 |
| Age | | | | |
| 16-30 years old | 1.12 | 1.01 | 1.30 | 0.86 |
| 31-50 years old | 0.96 | 0.98 | 1.03 | 1.06 |
| 51 and more years old | 0.93 | 1.04 | 0.47 | 1.04 |
| Level of study | | | | |
| Illiterate | 0.00 | 0.40 | 0.13 | 0.37 |
| Compulsory studies | 0.55 | 0.87 | 0.34 | 0.46 |
| High School graduates | 1.30 | 0.77 | 1.26 | 0.89 |
| Vocational Training | 1.65 | 1.77 | 1.20 | 0.91 |
| Three years college graduates | 1.17 | 0.70 | 1.65 | 2.14 |
| Five years college graduates | 1.26 | 0.92 | 2.23 | 2.28 |
| Work status | | | | |
| Employer | 0.72 | 0.49 | 0.67 | 0.70 |
| Self-employed | 0.50 | 0.20 | 0.68 | 0.77 |
| Public sector employee | 0.00 | 0.08 | 1.04 | 2.00 |
| Private sector employee | 1.32 | 1.36 | 1.09 | 0.86 |
| Others | 0.87 | 1.13 | 0.45 | 0.49 |
| Occupation | | | | |
| Managers | 1.46 | 0.76 | 0.78 | 0.64 |
| Professionals | 0.99 | 0.68 | 2.06 | 2.93 |
| Technicians and Associated Professionals | 2.50 | 1.37 | 2.36 | 1.60 |
| Clerks | 1.50 | 0.70 | 2.93 | 1.33 |
| Service Workers | 0.07 | 0.04 | 0.14 | 0.79 |
| Agricultural Workers | 0.00 | 0.00 | 0.01 | 0.10 |
| Craft and related Trade Workers | 0.96 | 1.68 | 0.44 | 0.12 |
| Plant and Machine Operator and Assemblers | 1.30 | 3.05 | 0.39 | 0.15 |
| Elementary Occupations | 0.35 | 0.47 | 0.10 | 0.82 |
| Weekly working hours | | | | |
| Less that 20 hours | 0.06 | 0.07 | 0.54 | 1.43 |
| 20-29 hours | 0.50 | 0.28 | 0.64 | 1.38 |
| 30-39 hours | 0.38 | 0.27 | 1.27 | 1.94 |
| 40-49 hours | 1.35 | 1.52 | 1.08 | 0.74 |
| 50 hour and more | 0.91 | 0.57 | 0.75 | 0.67 |
| Working time | | | | |
| Full-time | 1.08 | 1.11 | 1.04 | 0.95 |
| Part-time | 0.40 | 0.19 | 0.68 | 1.38 |
| Overtime | | | | |
| Yes | 1.46 | 1.25 | 1.22 | 0.92 |
| No | 0.96 | 0.98 | 0.98 | 1.01 |
| Contract tenure | | | | |
| Permanent | 1.20 | 1.20 | 1.06 | 1.07 |
| Temporary | 0.61 | 0.61 | 0.88 | 0.87 |
| Job tenure | | | | |
| 1-6 months | 0.76 | 0.72 | 1.22 | 0.76 |
| 7-12 months | 0.79 | 0.77 | 1.17 | 0.93 |
| 13-24 months | 0.52 | 0.79 | 1.11 | 0.91 |
| 25-60 months | 0.94 | 0.88 | 1.08 | 0.93 |
| 61-120 months | 1.22 | 1.17 | 1.09 | 1.06 |
| More that 120 months | 1.20 | 1.20 | 0.77 | 1.13 |

Source: EPA. Second quarters.

The figures confirm many of the conclusions anticipated by the literature, emphasizing the idea that the dissemination of new technologies is an important factor that explains the sectoral differences in labour parameters:

1. The presence of women in the industrial activities of high and upper intermediate technological intensity and in high-technology services is less frequent than in total employment. Nevertheless, female employment is relatively more frequent in the O-KIS.

2. Employees in activities most related to T&K are younger than the average for all the economy.

3. A positive relation is observed between T&K activities and the level of education of the workforce.

4. Employment in T&K sectors is mainly wage-earner employment. In manufacturing sectors it is mostly in private activities, whereas in O-KIS it is strongly oriented towards the public sector.

5. The structure of occupations differs between manufacturing and services. In manufacturing, the incidence index is highest for technicians and plant and machine operators. In services, all the non-manual (white collar) occupations show high incidence indexes, especially in the case of professionals, and to a lesser extent administrative staff.

6. Manufacturing and services also differ with regard to the length of working time. In manufacturing, the index is highest for 40- to 49-hour working weeks, whereas in services it is highest for 30- to 39-hour working weeks.

7. In comparison with total employment, only O-KIS appear to favour part-time work, whereas full-time work is more frequent in HT-M, MHT-M and HT-KIS.

8. Overtime is more frequent in high-tech manufacturing sectors and high-technology services.

9. The employment in T&K is stable, and permanent contracts are predominant.

10. Job tenure in T&K appears to be relatively high. All T&K sectors show high indexes for five or more years of seniority, except HT-KIS, in which job tenure seems to be substantially lower.

To sum up, on the basis of the above analysis it can be seen that technology and knowledge-intensive sectors introduce important changes in employment: women gain a more prominent role, the workers are younger, higher levels of education are required, the human capital seems to need more labour stability, and some indications of

flexibility are observed in the organization of work. New technologies and knowledge therefore appear to be related to the emergence of new forms of labour organization.

## 4. FEMALE EMPLOYMENT IN RELATION TO TECHNOLOGY AND KNOWLEDGE

We considered the effects induced by new technologies and knowledge from a gender perspective in order to determine whether T&K activities improve the unfavourable position of women that is usually observed in the Spanish labour market. The employment situation of women was characterized by sectors of activity on the basis of their relation to technology and knowledge by means of the indexes of gender distribution, concentration and segregation[5]. Then, in order to find some explanations for the results, a shift-share analysis was performed.

A simple glance at the 2006 figures suggests that technology and knowledge reduce the traditional gender inequality in the labour market to some extent (see Table 4):

1. Two of the three groups of services could be defined as feminized. This is especially marked in the other knowledge-intensive services (O-KIS).

2. The rest of the activities show a male gender composition, including the high- and medium to high-technology manufacturing sectors.

3. The most important result is that the group of all the activities associated with technology and knowledge (i.e. T&K, which includes HT-M, MHT-M, HT-KIS and O-KIS) can be considered as feminized, with 51.2% of their employment being female.

The conditions of the labour market in activities related to the new technologies and knowledge thus create a more favourable environment for female employment, whereas the more traditional sectors of activity are male-dominated. There is a very high growth of female employment

[5] The distribution index calculates the proportion of women employed in a sector and allows us to determine whether the activity is masculine, feminine or integrated (Hakim, 1993), according to the comparison of the weight of female employment in the sector and in total employment. We use the index of concentration to determine where women are most employed (the percentage of women who are employed in a sector to total female employment). Finally, to calculate the segregation we use the index of dissimilarity of Duncan and Duncan (Duncan and Duncan, 1955), defined as the semi-sum, for all the sectors considered, of the differences in absolute value between the indexes of concentration of male and female employment.

in the MHT-M group, and female employment is also growing—less intensively but more than the aggregate—in HT-KIS activities. It is important to note that almost 40% of female employment is concentrated in T&K activities, and the percentage rose by almost 7% from 1996 to 2006.

Table 4.
**Distribution and concentration rates of female employment by sectors of activity, classified on the basis of its relation with technology and knowledge. Spain (1996 and 2006)**

| | Index of distribution | | | Index of concentration | | |
|---|---|---|---|---|---|---|
| | 1996 | 2006 | Relat. var. | 1996 | 2006 | Relat.var. |
| **HT-M** | 32.3 | 29.5 | -8.6 | 0.5 | 0.3 | -34.8 |
| **MHT-M** | 14.2 | 19.4 | 37.1 | 1.9 | 2.0 | 3.9 |
| **LMLT-M** | 24.9 | 26.1 | 4.9 | 9.7 | 7.2 | -25.7 |
| **HT-KIS** | 27.1 | 34.0 | 25.7 | 1.5 | 2.2 | 52.7 |
| **O-KIS** | 53.3 | 58.8 | 10.2 | 33.4 | 35.3 | 5.6 |
| **L-KIS** | 40.6 | 50.0 | 23.1 | 45.3 | 47.6 | 5.0 |
| **OA** | 13.9 | 11.6 | -16.0 | 7.7 | 5.3 | -30.4 |
| **T&K** | 45.0 | 51.2 | 13.8 | 37.3 | 39.8 | 6.7 |
| **REST** | 30.4 | 35.7 | 17.4 | 62.7 | 60.1 | -4.1 |
| **TOTAL** | **34.6** | **40.6** | **17.2** | **100.0** | **100.0** | **0.0** |

Source: EPA. second quarters.
Note: Cells in gold colour indicate groups of activities of feminine definition. Cells in pink colour indicate groups of activities of masculine definition. Cells in white colour indicate groups of activities of integrated definition.

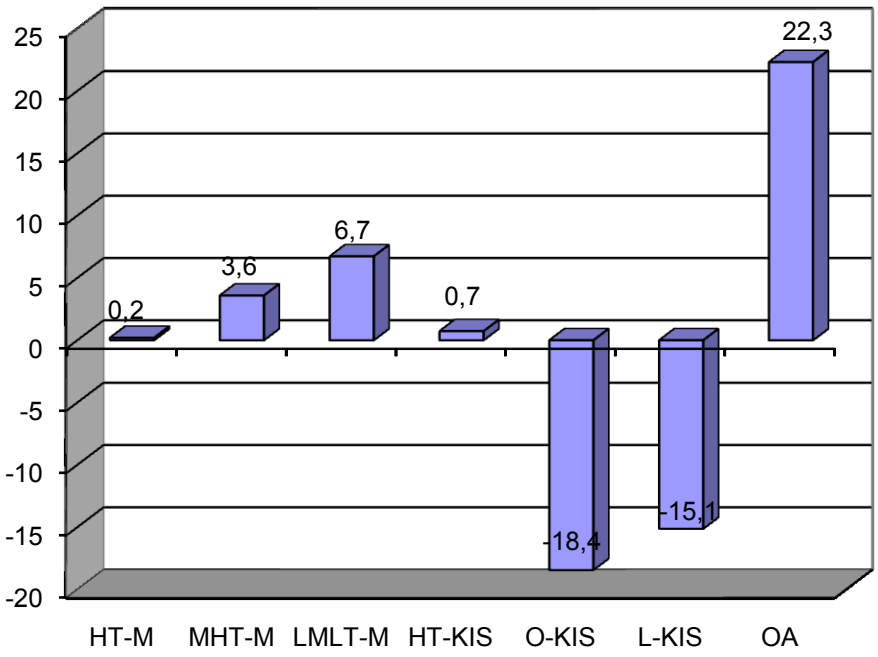
However, in spite of these positive trends, 28% of workers (men or women) in 1996 and 34% in 2006 should change their location in order to achieve an egalitarian sectoral distribution by gender. This shows that sectoral gender segregation still persists in the labour market.

To indicate the role played by the different groups of activities with regard to gender segregation, Figure 1 shows the differences of concentration of male and female employment in each sector[6]. Only two groups of services contribute negatively to the segregation (O-KIS and

L-KIS). Furthermore, most of the segregation is in the groups of other activities (OA) and low-and medium to low-technology manufacturing (LMLT-M). Both the medium to high-technology manufacturing sectors (MHT-M) and the high-technology services (HT-KIS) contribute only slightly to the segregation. Therefore, it can be concluded that technological intensity does not contribute to sectoral gender segregation, whereas knowledge intensity reduces it substantially.

[6] Negative signs indicate sectors in which the concentration of women is greater than that of men, which would reduce the magnitude of the final segregation.

Figure 1.
**Differences between male and female employment concentration by sectors of activity, classified on the basis of its relation with technology and knowledge. Spain (2006)**




Source: EPA. second quarters.

Finally, we wished to ascertain the reasons why T&K activities are more feminized than the other sectors (REST). For this purpose, we carried out a shift-share analysis between T&K and REST, following the strategy (Jimeno, 1997):

$$\sum_i^N \alpha_i^{T\&K} u_i^{T\&K} - \sum_i^N \alpha_i^{REST} u_i^{REST} = \sum_i^N (\alpha_i^{T\&K} - \alpha_i^{REST}) u_i^{REST} + \sum_i^N (u_i^{T\&K} - u_i^{REST}) \alpha_i^{T\&K}$$

where $\alpha$ is the weight of the different groups over total sectoral employment (women by age, level of education and occupation) and $u$ are its specific indexes of female distribution.

Following this equation, the difference between the female distribution indexes of the groups T&K and REST (the first term of the equation) might be due to two different facts: either the structure of the female population is different (the "structure effect", the first addend of the second term of the equation), or the different groups have different distribution indexes (the "feminization effect", the second addend of the second term of the equation).

We performed this decomposition for the three variables that we considered might be most likely to explain the differences, i.e. age, level of education and occupation.

To sum up, the analysis will show whether the comparatively high level of female employment in T&K is due to:

1. A structure effect. Employment in T&K and REST shows differences in composition by age, educational level and occupation. The greater presence of certain groups of women, associated with greater distribution indexes, would explain the result observed (for example, young women show a similar degree of feminization of their employment in both aggregates, but a greater percentage share in T&K).

2. A feminization effect. Employment in T&K and REST shows no significant differences in the composition of female employment. However, certain groups of women show greater distribution indices in T&K than in REST (for example, young women have a similar weight in both groups, but their employment is more feminized in T&K).

The structure effect indicates that the greater feminization of employment in T&K is not directly related to the application of new technologies and knowledge requirements, but rather to the differences in the composition of its employment. On the other hand, the feminization effect indicates that, regardless of the composition of employment in the two groups, new technologies and knowledge entail greater feminization in T&K.

Table 5 shows the results obtained. If we concentrate on the entire effects (in gold) from the perspective of age, the feminization effect explains all the difference between T&K and REST. By occupations the result is similar but even more marked, because the structure effect contributes negatively to the explanation of the difference. Finally, by educational level, the feminization effect is clearly predominant, although in this case the structure effect shows a moderately positive value.

It can therefore be concluded that the comparatively high presence of women in T&K cannot be explained by the fact that the composition of employment is biased towards the most feminized groups (only a moderate effect is observed by educational level). On the contrary, the structure of employment in T&K and REST is quite similar, but T&K employment is more feminized.

Table 5.
**Contribution of different groups of women to the feminisation of employment in technology and knowledge sectors of activity (T&K). Spain (2006)**

| Women groups | Structure effect | Feminisation effect |
|---|---|---|
| 16-24 years old | -12.9 | 7.4 |
| 25-34 years old | 1.4 | 28.4 |
| 35-44 years old | 5.9 | 35.5 |
| 45-54 years old | 5.3 | 21.5 |
| 55-64 years old | -0.3 | 8.6 |
| 65 years old and more | -0.8 | -0.1 |
| Total age | -1.4 | 101.4 |
| Illiterate | -4.8 | 1.9 |
| Compulsory studies | -49.8 | 23.0 |
| High School graduates | -13.5 | 6.2 |
| Vocational Training | -0.5 | 14.6 |
| Three years college graduate | 45.9 | 17.8 |
| Five years college graduate | 51.2 | 8.0 |
| Total level of study | 28.5 | 71.5 |
| Managers | -20.1 | -2.0 |
| Professionals | 129.2 | 64.0 |
| Technicians and Associated Professionals | 35.6 | 4.8 |
| Clerks | 24.4 | 5.7 |
| Service Workers | -126.7 | 14.5 |
| Agricultural Workers | -6.2 | -0.1 |
| Craft and related Trade Workers | -2.7 | 0.0 |
| Plant and Machine Operator and Assemblers | -2.1 | 1.7 |
| Elementary Occupations | -53.4 | 33.3 |
| Total occupation | -22.0 | 122.0 |

Source: Own elaboration from EPA. second quarters.
Note: Cells in gold point out total effects. Cells in green point out predominant effects for each category.

The results obtained for each category of the variables included in the analysis show that T&K activities enhance the feminization of employment particularly in the following cases:

1. Age: between 25 and 54.
2. Educational level: compulsory education, vocational training and three-year college course graduate.
3. Occupation: professionals and, surprisingly, elementary occupations.

These categories are more feminized in T&K activities than in the rest of the economic activities.

Finally, the "structure effect" is also important in some cases. Employment in T&K appears to be biased towards university graduates and white-collar occupations (professionals, auxiliary technical and professional staff, and administrative staff).

We can thus conclude that the technology- and knowledge-intensive sectors are only slightly differentiated from the rest in the composition

of their employment by age and occupation, although they moderately favour the employment of university graduates, a group which is feminized. Therefore, the T&K sectors must have some characteristics that stimulate the higher presence of women in them.

## 5. CONCLUSIONS

Information and communication technologies (ICTs) are leading to profound changes in economic activity and employment. The dissemination and large-scale use of ICTs has led to an increase in the rate of organizational and technological innovation, the development of knowledge-intensive services, and higher qualification requirements for many sectors of the employed population. There are also signs that this new labour context may offer new opportunities for women. Several studies have considered the relative advantage of women in terms of their level of education and labour flexibility, and the emergence of greater possibilities for achieving work-life balance. Within this context, based on an exhaustive review of the literature, the analysis pursued three main objectives.

We wished to determine, firstly, the way in which the evolution of the sectoral structure of employment in Spain is related to technological and knowledge intensity, as an expression of the ongoing spread of technology. The activities related to technology and knowledge are already fairly important in Spain in terms of volume of employment. According to the EPA for the second quarter of 2006, as much as 31.6% of all employment is in this type of activity. Furthermore, patterns of evolution are observed that favour this type of sector, particularly in relation to two of the four types of activity that we have characterized as related to technology and knowledge: high-technology knowledge-intensive services (HT-KIS), and other knowledge-intensive services (O-KIS).

Secondly, we analysed the characteristics and conditions of employment in sectors related to the spread of new technologies. This type of activity shows considerable differences in its characteristics and conditions of employment. These sectors have a younger workforce with high levels of qualification (the relation between technology- and knowledge-intensive activities and the level of training of their workforces is fairly clear), greater employment stability and certain elements of flexibility associated with the organization of their work processes, in particular working time. It thus seems that, as suggested above, flexibility must be combined with employment stability, which is essential in order to retain the knowledge of employees

Thirdly, we wished to determine whether and why these sectors favour the position of women in the labour market. The aggregate (T&K) shows that women represent 51% of employment, while some of its

components (HT-KIS) have shown a particularly rapid growth in the presence of women in their workforces. Furthermore, it seems that technological intensity does not contribute to the level of gender segregation in employment, whereas knowledge-intensity reduces it.

In order to determine the reasons for the differences between T&K and other activities, we carried out a shift-share analysis. The results of the decomposition show the feminization effect to be the important reason for these differences. It is thus concluded that the composition of employment in these activities is particularly favourable to some characteristics of female employment, and that the nature of T&K sectors favours their feminization.

The good results obtained contrast with the fact that, overall, male employment is predominant in manufacturing (with a lower presence of women than the national average), whereas female employment is predominant in knowledge-intensive services, particularly in the public sector. In general, the presence of women is lower in the two manufacturing groups than in the two tertiary groups. Therefore, the effect of ICT employment has no great effect on gender segregation in the economy as a whole: men tend to be concentrated in certain branches and occupations that can be considered as masculine (industrial and manual), whereas women are concentrated in services and indirect tasks. The two manufacturing groups show greater relative frequencies among auxiliary technical and professional staff, and among manual workers. The two groups of services show a high presence of all non-manual activities, particularly professionals, auxiliary technical and professional staff and, to a lesser extent, administrative staff.

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## ANNEX - DEFINITIONS

### Science and engineering fields of study

Science and engineering includes life sciences, physical sciences, mathematics and statistics, computing, engineering and engineering trades, manufacturing and processing, architecture and building (ISCED-97 educational fields 42, 44, 46, 48, 52, 54, 58).

### Sectors of activity, classified on the basis of their relation to technology and knowledge

In order to relate sectors of activity to technology and knowledge, we have used the classification proposed by Eurostat (2006), which divides sectors on the basis of the overall R+D intensity. Following a similar criterion, services are also classified on the basis of the intensity of knowledge requirements. The outcome of these two criteria is:

1. A group of **high-technology manufacturing (HT-M)** composed of Manufacture of office machinery and computers; Manufacture of radio, television and communication equipment and apparatus; and Manufacture of medical, precision and optical instruments, watches and clocks (NACE-93 codes 30, 32 and 33).

2. A group of **medium to high-technology manufacturing (MHT-M)**, which includes Manufacture of chemicals; Manufacture of machinery and equipment; Manufacture of electrical machinery and apparatus; Manufacture of motor vehicles, trailers and semi-trailers; and Manufacture of other transport equipment (NACE-93 codes 24, 29, 31, 34 and 35).

3. A group of **high-technology, knowledge-intensive services (HT-KIS)** composed of Post and telecommunications; Computer and related activities; and Research and development (NACE-93 codes 64, 72 and 73).

4. Finally, a group of **other knowledge-intensive services (O-KIS)** composed of Water transport; Air transport; Financial intermediation, except insurance and pension funding; Real estate activities; Renting of machinery and equipment without operator and of personal and household goods; Other business activities; Education; Health and social work; and Recreational, cultural and sporting activities (NACE-93 codes 61, 62, 65, 66, 67, 70, 71, 74, 80, 85 and 92).

These four groups make up the sectors of activity related to technology and knowledge, which we name **T&K**.

The sectors of activity not related to technology and knowledge are named **REST** and include:

1. Low- and medium to low-technology manufacturing (LMLT-M) (NACE codes 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 36 and 37)

2. Less knowledge-intensive services (L-KIS) (NACE codes 50, 51,52, 55, 60, 63, 75, 90, 91, 93, 95 and 99)

3. and, finally, the group of other activities (OA) (NACE codes 1, 2, 5, 10, 11, 12, 13, 14, 40, 41 and 45).

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