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UNDERSTANDING OFFSHORING: HAS SPAIN BEEN AN OFFSHORING LOCATION IN THE NINETIES? ♣

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Abstract:

Offshoring of production is becoming a significant strategy in Spanish manufacturing industry. The aim of this paper is to examine the implications of offshoring on the relative demand for labour in Spanish manufacturing industry during the 1990's. We focus on changes in the relative composition of employment and in the wage gap in order to get results than may offer some insight into the direction of offshoring. A GMM approach is used to estimate a dynamic panel data model which includes migrant labour and temporary employment rate as explanatory variables. Our econometric results suggest that, as opposed to most developed countries, offshoring in Spain has favoured the demand for blue-collar workers and has also contributed to narrowing the wage gap between white-collar and blue-collar workers. Based on these findings, we can infer that global production networks are using Spain as an attractive location for medium and high technology industries.

JEL classification: F16, L23

Keywords: Offshoring, Manufacturing Industries, Relative Demand for Labour, Global Production Networks.

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1. INTRODUCTION

One of the most distinctive features of recent globalization is the increased fragmentation of production. This trend, called "offshoring", involves a process of splitting up and spreading previously integrated stages of production over an international network of production sites. This means that parts of the ongoing production of goods or services are moved abroad and that they are supplied either by independent foreign suppliers or by associated companies.

This research is focused on production offshoring in manufacturing industries mainly for two reasons. First, as Amiti and Wei (2005) and Hijzen (2005) point out, although offshoring of services in developed countries has rapidly increased in recent years, its magnitude is still low compared to offshoring of production in the manufacturing sector. Second, as argued by Kirkegaard (2004), most of the jobs lost between 1999 and 2002 in the category he defines as "occupations with a risk of offshoring" were not related to services but to manufacturing industries. That is why the vast majority of the empirical literature on offshoring focuses on material offshoring.

The international relocation of production activities has received a lot of attention in recent times, and often in relation with the increasing fear of domestic job losses. The aim of this paper is to examine the implications of offshoring on the relative demand for labour in Spanish manufacturing industry during the 1990's. We focus on changes in the relative composition of employment and in the wage gap in order to get results than may offer some insights into the direction of offshoring. This is a new approach to understanding the pattern of offshoring in the intermediate developed countries.

Previous empirical analysis shows how, in the most advanced economies such as the U.S. and other OECD countries, offshoring involves the moving the most labour-intensive stages of the production process to low cost locations. These stages are the most intensive in low skilled labour and include, by definition, routine tasks. Therefore, their delocalization has an adverse effect on low skilled workers. On the other hand, evidence from less developed countries, such as those of Eastern Europe, suggests an effect that is biased in favour of that category of low skilled workers.

Spanish manufacturing industry shares characteristics of both types of countries. On the one hand, its smaller research effort moves it away from the main European and world leaders in terms of technology and knowledge. Moreover, the most labour intensive activities with

low technological content prevail in Spanish industrial production[1]. In fact, the relative weight of those sectors with the highest technological content has decreased since the mid 1990s and their importance within the industrial structure is one of the most limited in the EU-15. This is especially evident in those sectors more closely linked to information and communication technologies (ICT)[2]. Thus, Spain, as opposed to the most advanced European economies, forms part of a group of countries that base their competitive advantage mainly on their lower production costs, offering a good price-quality ratio. But, in spite of that, there is no doubt that, in the world context the Spanish economy has relatively high levels of income and wages. Also, its infrastructures, human capital and institutional quality bring Spanish economy closer to the most advanced countries than to developing ones.

In Spanish manufacturing industry, offshoring of production has become a significant strategy in recent decades, as it has in the most advanced economies. However, it is unclear the direction of such strategy. The strong connection between offshoring and the evolution of Spanish industry's export propensity[3] suggests that Spain is involved in international production networks for some manufacturing activities. Spanish firms could be being used by other advanced countries as an assembly platform and, therefore, as an export platform to foreign markets. In this situation, typical of developing countries, we could expect shifts on the relative demand for labour which would favour less skilled labour.

In contrast with that, it is quite feasible that one of the objectives of the increasing internationalization of Spanish industrial companies would be to obtain cost-related advantages by delocalizing some production stages to less developed countries. This could be especially truth for labour intensive manufactures due to an increasing competitive pressure from lower cost producers. In this scenario, typical of advanced economies, we could expect changes on the relative demand for labour which would favor high-skilled workers. Obviously, the economic consequences for the national industry and economy would be different in each case, hence the interest of determining the direction of offshoring in the Spanish economy. This paper provides new evidence on that question.

An additional contribution from this paper is the inclusion of migrant labour and of the temporary employment rate as variables to explain the changes in the composition of labour.

[1] In 2005, 62% of manufacturing added value came from traditional industries, mainly foods and beverages, non-metallic mineral products, metal products and pulp & paper products; while the corresponding figure in EU-15 was 51% (Myro & Gandoy, 2007).
[2] Alvarez *et al*. (2007).
[3] Díaz-Mora *et al*. (2007).

Both of them could be being used as a substitute for offshoring strategies in developed countries.

From our findings, we can advance that offshoring in Spanish manufacturing industry during the nineties, unlike what has happened in other developed countries, has favoured the demand for blue-collar workers and has also contributed to narrowing the wage gap between white and blue-collar workers. This effect is robust to controlling for the possible endogeneity of offshoring and migrant labour by employing the system generalized method of moments (GMM) estimation.

The outline of this study is as follows. After this introduction, in Section 2 we present the main previous contributions in this field. Then, in Section 3, we schematically analyze the magnitude and evolution of offshoring in Spanish manufacturing industry since the early nineties, as well as the changes in the relative composition of labour and in the wage gap between the different professional categories. In Section 4 we present the econometric model and our main findings. In Section 5 we draw some conclusions and put forward our final considerations.

2. REVIEWING THE LITERATURE: OFFSHORING AND EMPLOYMENT STRUCTURE

Offshoring effects on employment and on the composition of the demand for labour by skills have mainly been studied for the most developed countries. In these countries the potential loss of jobs associated to the delocalization of some parts of the production process has raised considerable concern. Unlike what happens with the literature on the effects of offshoring on total employment, there is a widespread consensus amongst authors about how offshoring changes the composition of labour and the wage gap between categories of workers.

The main theoretical[4] and empirical[5] contributions in this field in relation to advanced economies agree that offshoring affects the labour market in the country whose production is relocated, increasing relative demand for high-skilled workers (non manual or white-collar employees) and considerably reducing the share of workers performing tasks more directly related to the physical production of goods (manual or blue-collar workers). In parallel with

[4] For example Feenstra and Hanson (1996 and 1999) and Kohler (2001 and 2004).

this, the greater relative demand for non-manual workers results in shifts in the relative costs of both types of labour in favour of job categories that are least affected by the delocalization. Consequently, offshoring leads to a widening of the wage gap between the two types of workers: blue-collar and white-collar[6, 7].

Related to this argument, it should be noted that the labour markets effects of offshoring will depend on the flexibility of national labour markets. In highly rigid labour markets, as is the case of most European economies[8], the incidence of offshoring reflects mainly in changes in the composition of labour, with very few alterations in relative wages. The opposite will be the case in countries with more flexible labour markets.

Another aspect to be taken into account in the analysis is the role of technical progress. Like most empirical studies have noted, technological progress works in the same direction as offshoring, increasing demand for highly-skilled workers or for workers from a higher professional category and increasing wage inequalities between skilled and unskilled workers. In fact, many of the studies find technical progress as the main cause for the widening of the wage gap and for changes in the composition of labour.

For countries that receive offshored activities, the consequences of offshoring are quite clear from a theoretical point of view. According to economic theory predictions, since offshoring mainly involves low-skilled segments of production, blue-collar workers should benefit in those countries to which production is relocated[9]. From an empirical perspective,

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[5] Among these studies are Feenstra and Hanson (1996) for the USA, Helg and Tajoli (2005) for Italy, Strauss-Kahn (2004) for France, Hijzen *et al*. (2005) for the United Kingdom and Dell'mour *et al*. (2000) for Austria. All of them come to a similar conclusion using different methodologies.

[6] This result is shown in Feenstra and Hanson (1999) for the USA, Hijzen (2005) for the United Kingdom and Geishecker and Görg (2005) for Germany.

[7] However, this does not mean that the strategy is necessarily harmful to blue-collar workers. Authors like Grossman & Rossi-Hansberg (2006) maintain that although it effectively increases the wage gap, in the long run both groups of workers can obtain an increase in their wages of if the costs savings derived from offshoring lead to an improvement in the efficiency of production and the company's competitive position. Other theoretical contributions such as Arndt (1997, 1999) and Jones and Kierzkowsky (2001) also show that, in some limited cases, offshoring can improve the blue-collar workers' employment conditions and narrow the wage gap between both groups of workers.

[8] According to OECD data on Employment Protection Legislation (EPL), the countries with the lowest level of labour rigidity are USA, United Kingdom and Canada, with values of around 0.2-0.8, therefore their labour markets can be considered flexible; as opposed to most European economies with rigid labour markets, which include Portugal, Spain and France, whose indexes are over 3. The index goes from 0 (the lowest level of labour rigidity) to 10 (the highest level of labour rigidity).

[9] The relative increase in the number of workers not directly associated to production and in their wages, as observed by Feenstra and Hanson (1996 and 1999) for the Mexican economy, may be a problem for this interpretation. Their study shows that Foreign Direct Investment (FDI) into the *maquiladora* sector, which is closely linked with offshoring activities, can account for a large portion of the increase in the skilled labour share of total wages and for a related shift in relative wages. The explanation for this behaviour, quite different to theoretical predictions, is that the phases relocated by North American companies are more intensive in skilled

unlike what happens with the most developed countries, there are few empirically based studies about the less developed economies, the ones which receive the relocated phases. One outstanding case is the study by Egger and Stherer (2003), which analyses the effect of offshoring on three Eastern European countries (the Czech Republic, Hungary and Poland) during the 1990s. They find a bias in favour of the employment and wages of less skilled labour, which has led to a decrease in the wage gap. While the skill premium in all three countries has risen over the period, offshoring activities have helped to contain this rise[10].

All in all, the offshoring literature seems to reveal a different impact of offshoring on the composition of labour and on the wage gap in the countries that implement the strategy and the countries that receive the relocated phases. Therefore, an analysis of the effect of offshoring on the relative demand for labour and on relative wages by skill may give us new insights into the direction taken by offshoring. We will specifically apply the analysis to the case of Spanish manufacturing industry.

3. OFFSHORING AND ITS EFFECTS IN SPANISH MANUFACTURING INDUSTRY

3.1 Offshoring in Spanish manufacturing industry

Before carrying out any empirical estimation of the effects of offshoring on the Spanish labour market, it would be useful to know how this strategy has been implemented in its manufacturing industry from the early nineties to the present day.

Our main measure of offshoring captures the changes in the share of imported intermediate inputs for production and is similar to those measures used by other works[11]. Following the terminology used by Feenstra and Hanson (1999), we use the narrow definition of offshoring (ON), which only includes imported intermediate inputs from the importing industry, i.e. an industry's purchases of imported intermediate inputs produced in the same industry (which corresponds to diagonal terms of the import-use matrix provided by the National Institute of Statistics)[12]:

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labour than the activities previously done in Mexico. This explanation, however, cannot easily be applied to Spanish manufacturing industry.

[10] Bruno *et al*. (2005) find that FDI has not worsened inequality by favouring labour demand shifts in the three countries.

[11] Ekholm and Hakkala (2006), Hijzen *et al.* (2005) and Amiti y Wei (2005).

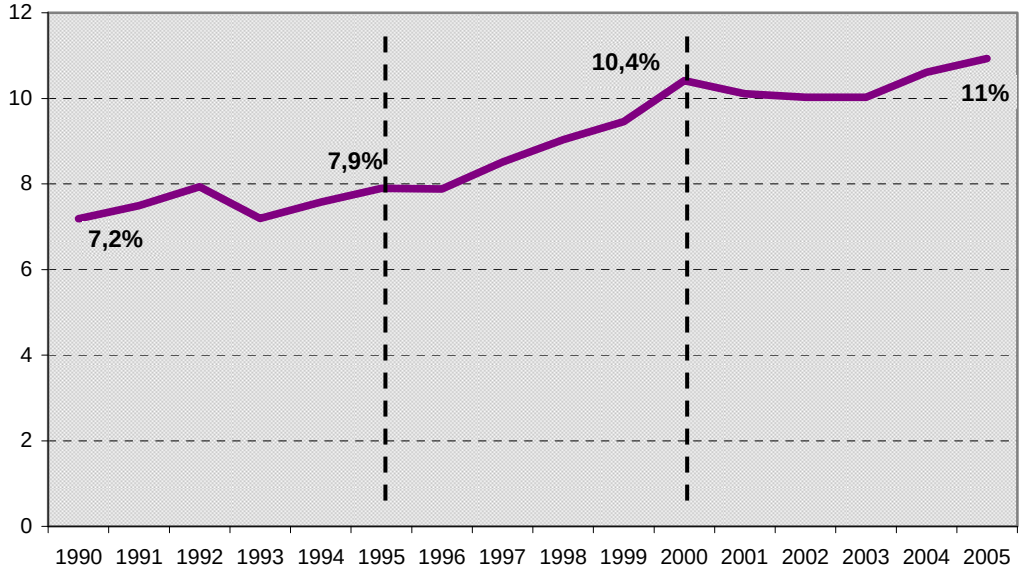
[12] The authors argue that the narrow definition is preferred to a broader definition, imported inputs from all industries, since the former is closer to what is thought of as fragmentation within industries. This is especially likely to be the case when we carry out the analysis based on a relatively aggregated industry level. However, they note that the distinction between the narrow and broad definitions of outsourcing is not without problems.

$$ON_{jt} = \Delta\left(\frac{III_{i=j,t}}{VP_{jt}}\right)$$

where *III* indicates the value of imported intermediate inputs from industry *j* abroad and *VP* gives the production value of industry *j* in period *t*[13].

Chart 1 shows how offshoring of production has played an increasing role in Spanish manufacturing industry from 1990 to 2005. The dependence on the import of intermediate goods in the manufacturing sector has increased from 7.2% in 1990 to 11% in 2005, with an increase just over 50% during the entire period. The dynamics of this strategy was particularly intense in the late nineties, when the rate increased by 2.5 percentage points, and the imported inputs amounted to 10.4% of the production in 2000.

CHART 1: DEPENDENCE ON IMPORTED INPUTS IN SPANISH MANUFACTURING INDUSTRY
(III/VP in percentage, 1990-2005)



Source: Input-Output Tables, Industrial Company Survey (National Institute of Statistics) and Comext (Eurostat).

An analysis by sectors shows that the increase in offshoring was shared by most industries for the five-year period from 1995 to 2000. In this period offshoring was more important in some industries with high technological content such as office machinery and computer systems, electric and electronic machinery and materials, motor vehicles and

[13] Statistical sources are detailed in the Statistical Annex.

trailers, and some labour intensive manufacturing sectors such as the textile industry and the wood and cork industry[14].

3.2 Relative wages and employment in Spanish manufacturing industry

Most of the earlier studies have identified workers associated to production as being the least skilled[15]. In this study we have adopted the distinction between the categories of "Employees" and "Operators" provided by the *National Institute of Statistics* in the *Wage Survey for Industry and Services*. This is justified by the characteristics of the Spanish economy and the lack of a correspondence between the level of educational attainment and the professional activity of the workforce. In this way, "Employees" are identified with workers that are not directly associated to production tasks (non-production or white-collar workers) while "Operators" are those workers performing jobs directly related to the physical production of goods (production or blue-collar workers).

The evolution of the relative employment in Spanish manufacturing industry (measured as the average number of *Employees* compared to the number of *Operators*) shows that *Employees* increased at a faster rate than *Operators* over the 1990-2000 period. Relative employment has moved in favour of workers in higher professional categories (1.24% annual cumulative) (Table 1). This evolution is a common trend in many developed countries. However, the profile over time shows that this increasing tendency breaks midway through the decade and also that, since that time, there is a change in the relative composition of employment in favour of blue-collar workers (Table 1 and Chart 2).

Also, a very slight increase in the employment of higher labour categories (0.42% annual cumulative) and a major decrease in the number of blue-collar workers (-3.64%) can be observed in the first five years of the decade. In contrast, in the second half of the decade, a significant growth in both groups of occupations occurred, although such increase was more significant for workers in the lower professional category (increase of 4.01% as opposed to 2.3%). This pattern has changed the relative composition of employment in favour of blue-collar workers. The above described situation is undoubtedly peculiar to the Spanish industry, and cannot be seen in other advanced economies.

[14] A thorough exploration of the offshoring of production in different activity sectors of the Spanish manufacturing industry from 1995 to 2004, its measuring problems and indicators, can be found in Díaz-Mora *et al*. (2007).

[15] Berman *et al*, (1994 and 1998); Machin and Van Reenen (1998); Head and Ries (2002) and Egger and Stherer (2003), among others.

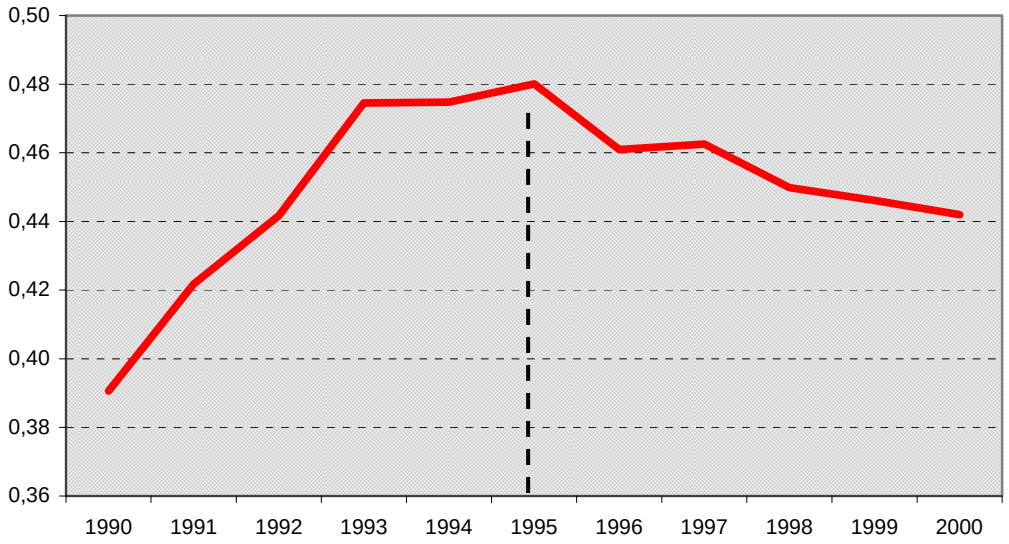
TABLE 1: EMPLOYMENT BY CATEGORIES OF WORKERS

(Annual cumulative variation rates)

	Employees (L^E)	Operators (L^O)	(Employees / Operators) (L^E / L^O)
1990-2000	1.35	0.11	1.24
1990-1995	0.42	-3.64	4.21
1995-2000	2.30	4.01	**-1.64**

Source: Wage Survey for Industry and Services, National Account and Industrial Company Survey (National Institute of Statistics)

CHART 2: EMPLOYMENT RATIO BY PROFESSIONAL CATEGORIES OF WORKERS (*EMPLOYEES* / *OPERATORS*) IN SPANISH INDUSTRY, 1990-2000

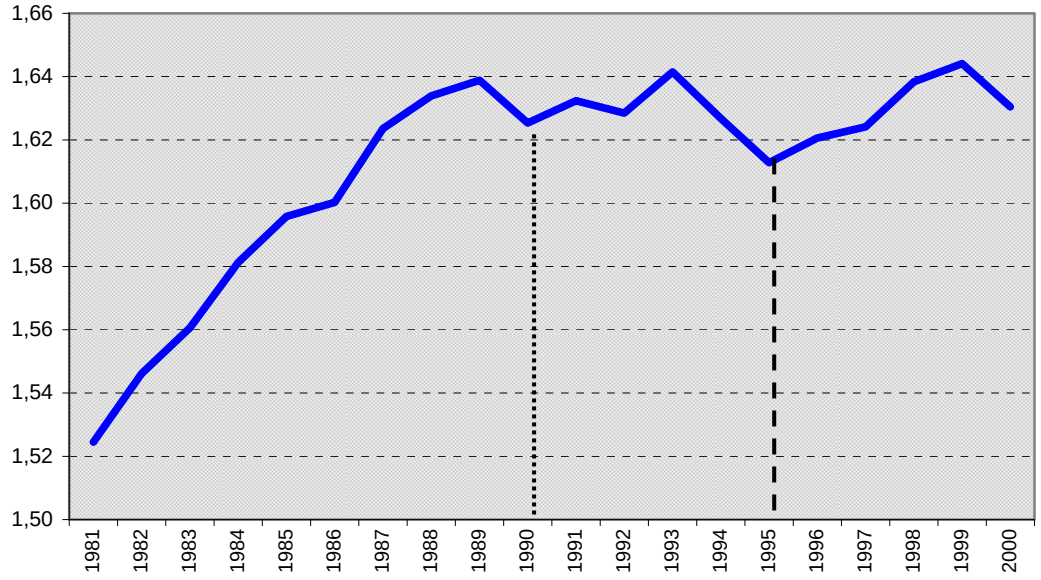


Source: Wage Survey for Industry and Services, National Account and Industrial Company Survey (National Institute of Statistics)

As for the evolution of the relative wages over the period of study, it is also far from being uniform (Chart 3). While in the eighties there were major increases in the wage gap in favour of white-collar workers, in the nineties changes can be considered as minor, even though there was a slight increase after 1995[16].

[16] A thorough review of the national and international empirical evidence about the evolution of the wage gap is provided by Carrasco (2006). According to this author, for most countries in the eighties, relative wages increased in favour of higher skilled workers or for those in the highest percentiles in terms of wage distribution, thus increasing the wage gap. However, in the nineties these inequalities did not increase or only did so very slightly. On the contrary, some studies on the Spanish economy that distinguish between skilled and unskilled workers depending on their education level find that in the eighties there was hardly any variation in the distribution of wages (Minondo, 2000) or that it even decreased (Abadíe, 1997).

CHART 3: WAGE RATIO BY PROFESSIONAL CATEGORIES OF WORKERS (*EMPLOYEES'* WAGES / *OPERATORS'* WAGES) IN SPANISH INDUSTRY, 1981-2000



Source: Wage Survey for Industry and Services, National Account and Industrial Company Survey (National Institute of Statistics)

The changes observed in relative employment may be the result of either shifts in the sectoral composition of employment related to technological progress or to the offshoring of routine tasks. Both circumstances will lead to a greater relative demand for labour in the higher labour categories "within" industries. But those two are not the only factors that can affect the composition of employment. As argued by the *Stolper-Samuelson* theorem, trade in final goods also generates shifts in the composition of labour "between" manufactures, since it enables developed countries to specialize in those final products that require higher levels of skills.

To determine which of these causes can mainly account for the shifts, and following Berman *et al*. (1994), the change in the share of blue-collar workers (*Operators*) in total industrial employment is broken down into two factors: the change in the distribution of employment that occurs "within" industries ("*within*" component) and the change in the distribution of employment that happens "between" sectors ("*between*" component). Thus, we have:

$$\Delta\left(\frac{L^O}{E}\right) = \underbrace{\sum_{i=1}^{n} \Delta\left(\frac{L^O}{E}\right)_i \times \overline{E}_i}_{\text{Within Component}} + \underbrace{\sum_{i=1}^{n} \Delta E_i \times \left(\overline{\frac{L^O}{E}}\right)_i}_{\text{Between Component}}$$

where L^O indicates the number of *Operators* workers and E represents the total manufacturing employment; the line over the variable denotes the average value for the study period and n is the number of manufacturing activities considered.

The shift-share analysis shows that between 1990 and 2000 the decrease in the relative share of workers from a lower professional category in Spanish industry has been of 1.41 percentage points. While changes in the composition of labour that happened "within" industries accounted for 1.38 percentage points, only 0.03 percentage points are attributable to shifts "between" industries (Table 2). Therefore, it seems that changes in the relative composition of labour are common across manufacturing sectors as it occurs in other developed economies[17]. Additionally, we observe that, although in the two halves of the decade the changes are attributable to the "within" factor, the trends of the two factors are in opposite directions. Therefore, as compared to early years of the decade, in its second half there was an increase in the share of Operators in the total labour force of Spanish manufacturing industries.

TABLE 2: INTRA AND INTER-SECTOR BREAKDOWN OF CHANGES IN THE SHARE OF *OPERATORS* IN TOTAL MANUFACTURING EMPLOYMENT

	Within	**Between**	**Total**	**Within / Total**
1990-2000	-1.38	-0.03	-1.41	97.7 %
1990-1995	-3.77	-0.27	-4.04	93.4 %
1995-2000	2.40	0.23	2.63	91.3 %

Source: Wage Survey for Industry and Services, National Account and Industrial Company Survey (National Institute of Statistics)

Once we have rejected the hypothesis that changes in labour demand in the Spanish industry over the last decade have been the consequence of structural changes, the next question should be the following: what factors lay behind these shifts? The numerous studies examining this behaviour in employment structure try to explain its evolution from two different points of view. The first doctrine considers that technological progress has a greater weight in this tendency: new technologies are complementary to high skilled workers but a substitute for unskilled labour. In this respect, its effects on the labour market tend to favour higher category occupations [18].

[17] Berman et al., (1994, 1998), Machin (1996), Bernard and Jensen (1997), Dunne *et al*., (1997), Osburn (2001).
[18] Berman *et al*. (1994, 1998), Autor *et al*. (1998)

The second view considers that the changes are due to the expansion of international trade[19]. However, at this point it is important to highlight that while the classic theory of international trade has traditionally focused on foreign trade in final goods (shifts "between" industries), trade in intermediate inputs and offshoring of production involve intra-industry and intra-product trade, which could lead to very different results in terms of the effects on changes in the relative structure of employment "within" industries between different levels of skills and/or categories of jobs. Increasing trade liberalization, competitiveness and technological progress have allowed a progressive integration of markets and a redistribution of production on an international scale. Firms in advanced countries may consider improving their productive efficiency by replacing their national suppliers of intermediate inputs or their more labour intensive components with cheaper foreign suppliers. Alternatively, they might delocalize abroad those relatively routine and less skill-intensive phases of production, taking it to countries with lower relative wages and then re-import the segmented production. Thus, they try to find the best location for their production, or for part of it, by delocalizing it to places where especially labour costs (among others) are comparatively lower and that also offer a good economic environment (good transport infrastructures and communications, healthy economic climate, political stability, access to international markets, etc.). This is even more the case when such conditions are found in growing markets (e.g. China, India or the Eastern European economies that have recently joined the EU).

In the econometric analysis presented in the following section we will examine the incidence of technological change and offshoring at the industry level on changes in the composition of labour and in the wage gap of workers within different professional categories.

4. MODEL SPECIFICATION AND IMPLEMENTATION

4.1 Specifications of the Model

The estimated model follows the standard empirical specification suggested by Berman *et al*. (1994), where the impact of offshoring on labour demand is modelled in a similar way as for factor-biased technological change (FBTC).

[19] Feenstra (1998) points out that previous studies on the negative effects on less skilled workers in developed countries had focused their debate on two explanations that were considered substitutes: technological change and international trade. But if there is also trade of intermediate goods, he considers the two explanations to be complementary, hence generating similar effects on employment.

The starting point of the econometric model is a cost function for each industry. Assuming that firms are profit-maximizing and the isoquants of the production function are convex, there is a variable unit cost function for each industry (CV_i) that, in this case, can be affected by two different types of structural variables: offshoring of production and technological change, as defined in the following expression:

$$CV_i = CV\left(w_i^E, w_i^O, Y_i, \frac{K_i}{Y_i}, OFFS_i, \frac{(R\ \&\ D)_i}{Y_i}\right),$$

where W_i^E are the *Employees*' wages, W_i^O are the *Operators*' wages, Y_i is the real production; (K_i/Y_i) expresses the quasi-fixed input represented by the intensity of capital; $OFFS_i$ is the indicator of offshoring of production, i.e. the changes in the percentage of intermediate inputs imported over the production and $(R\&D)_i/Y_i$ is defined as R&D expenditure made by each industry *i* divided by gross output, representing a measure of technical change.

This unit cost function can be approached, in the short term, by a general translog cost function, with variable and quasi-fixed inputs, as in Brown and Christensen (1981). In our analysis, we consider offshoring as a factor that changes the technology with which the domestic industry operates, but not necessarily in a way that affects all domestic input factors uniformly. For instance, offshoring of certain parts of the production process could raise productivity for certain domestic workers more than for others, leading to a shift in relative demand. To control for any FBTC induced by domestic innovation, we also include the industry's R&D intensity.

So, considering that industry *i* produces an output *Y*, that the variable production factors are the workforce in the two professional categories considered (white-collar *Employees* (E) and blue-collar *Operators* (O)) and that capital is the quasi-fixed input, after a series of derivations and applying *Shepard's Lemma*[20], we obtain the following estimating equation for the relative demand for labour:

$$S_{it}^E = \beta_E + \beta_w \ln\frac{w_{it}^E}{w_{it}^O} + \beta_Y \ln Y_{it} + \beta_K \ln\frac{K_{it}}{Y_{it}} + \beta_T \frac{(R\ \&\ D)_{it}}{Y_{it}} + \beta_O\, OFFS_{it} + u_{it}$$

[20] The application of the Shepard lemma allows deriving the function of the demand for labour, on the basis of a cost function, through a partial differentiation with respect to *w*. That is to say, $L = \frac{\partial CV}{\partial w}$.

where S_{it}^{E} indicates the share of *Employee* wage costs in total labour costs, defined as:

$$S_{it}^{E} = \left(\frac{(w_{it}^{E} \text{ x } L_{it}^{E})}{(w_{it}^{E} \text{ x } L_{it}^{E}) + (w_{it}^{O} \text{ x } L_{it}^{O})} \right)$$

where L_i is the number of workers.

Finally, u_{it} is an idiosyncratic shock affecting the share of *Employee* wage costs in total labour costs at time *t*.

In multiple applications of the translog cost function, the variable inputs prices $\left(w_{it}^{E}/w_{it}^{O}\right)$ are excluded from the estimations. According to Feenstra and Hanson (2003) and Berman *et al.* (1994), wages differ across industries mainly due to quality-variation of workers, so we do not expect high-wage industries to economize on those (high-quality) workers. In this regard, the wages of a certain type of worker in a specific industry are based on the inherent characteristics of the workers in that industry. Therefore, they will have little impact on the wages of workers in another industry. Accordingly, the wage terms are typically dropped from the right-hand side of the equation when pooling data across industries. Moreover, their inclusion is based on the assumption that wages are an exogenous variable to the industry, which would occur if the workforce were perfectly mobile between sectors; but if that is not the case and there are specific wage gains in each industry, then wages cannot be considered as exogenous. Nevertheless, if the equation did not include the costs of production factors, there would be a potential problem of omitted variables. Furthermore, although according to its definition the relative wage variable is correlated with the dependent variable, its inclusion in the specification of the model allows us to control for any variation in the composition of the dependent variable, leaving the other changes in relative employment to be explained by other exogenous variables specified in the equation. After balancing all those arguments, we have opted to include them.

From the original equation of the relative demand for labour, two specifications can be deduced. The specification (1) can be used to compare the effect of offshoring on changes in the relative employment between categories of workers, while the specification (2), for their part, considers the effects on the wage gap between *Employees* and *Operators*.

$$\Delta \frac{L_{it}^{E}}{L_{it}^{O}} = \beta_E + \beta_w \Delta \ln \frac{w_{it}^{E}}{w_{it}^{O}} + \beta_Y \Delta \ln Y_{it} + \beta_K \Delta \ln \frac{K_{it}}{Y_{it}} + \beta_T \frac{(R\&D)_{it}}{Y_{it}} + \beta_O OFFS_{it} + \beta_I \Delta IMM_{it} + \beta_T \Delta TEMP_{it} + \Delta u_{it} \quad \textbf{(1)}$$

$$\Delta \frac{w_{it}^{E}}{w_{it}^{O}} = \beta_E + \beta_Y \, \Delta \ln Y_{it} + \beta_K \, \Delta \ln \frac{K_{it}}{Y_{it}} + \beta_T \, \frac{(R \,\&\, D)_{it}}{Y_{it}} + \beta_O \, OFFS_{it} + \beta_I \, \Delta \, IMM_{it} + \beta_T \Delta TEMP_{it} + \Delta u_{it} \quad \textbf{(2)}$$

In both specifications, we have included migrant labour (IMM) and the temporary employment rate (TEMP) as variables that could account for the changes in the composition of labour in the way we will explain later.

Since our interest is focused on examining the effect of offshoring on changes in the relative composition of employment and in wage gaps, the variables in the model are measured in differences and they are approximated by the annual variation rates, except for the variable technical change[21]. Variables measurement and statistical sources are detailed in the Statistical Annex.

As for the signs of the variables considered in the model and according to the results obtained by numerous previous empirical studies above mentioned, we expect the following econometric results. The expected sign for the coefficient of relative wages in equation (1) is negative ($\beta_w < 0$); i.e. relative increases in the costs of *Employee* workers will favour a greater demand for *Operators*. However, this result will depend on the complementariness between both types of workers.

With respect to the sign of real production, *a priori* it may be ambiguous. If $\beta_Y > 0$, it would mean that an increase in the scale of manufacturing production would lead to a relative increase in *Employees* and their wages. On the contrary, if $\beta_Y < 0$, employment growth will favour *Operator* workers. This does not mean that when an industry increases its production scale it will not need more high skilled workers (if these correspond to those of a higher job category). Such industry will possibly demand more labour from higher job categories, but not in the same proportion as the production increase. For example, if production doubles, that does not necessarily require twice as many directors or advisors, but will need more *Operators*. Most studies find a positive correlation between a production increase and an increase in skilled labour; therefore, we expect a positive sign for the effect of real production on changes in employment and relative wages.

The sign of the coefficient of capital is, *a priori*, uncertain; it depends on whether blue-collar employment complements ($\beta_k > 0$) or substitutes ($\beta_k < 0$) capital in the industrial

[21] Changes on technological change are quite small in Spanish manufacturing, so we have decided that it is more relevant to include this variable in the model by levels.

production process. Usually, it is of a complementary nature[22] and, in this case, the coefficient is expected to be positive.

The β_T parameter reveals the effects of technological change. A positive value ($\beta_T > 0$) will indicate that a greater investment in R&D has a positive effect on the increase in *Employees* employment and wages. Authors like Berman *et al*. (1994) defend the idea that new technologies are a complementary factor of skilled labour and, thus, that technical progress will favour the relative demand for workers in higher job categories. Investment in research and development as a share of the production value or added value is usually used as a proxy measure for technological change by empirical literature.

The impact of offshoring of production on changes in the relative structure of employment is shown by parameter β_O and depends on the direction of the strategy. As already explained, a positive impact is expected in the economies– generally the most developed countries – that delocalize the routine and most labour intensive parts of the production process to geographical locations with lower relative costs. A negative sign is expected in the countries that receive that relocated production either for it to be assembled and then exported or for it to be incorporated in later stages of the final goods manufacturing process.

Including migrant labour and the temporary employment rate as variables that explain the changes in the composition of labour provides a relevant and novel contribution to the literature on offshoring. Although the study by Borjas, Freeman and Katz (1997) could, to a certain extent, be considered as a precedent of our approach since it takes into account the joint incidence of trade and immigration on the wage gap, there is a significant difference: it does not specifically consider offshoring[23].

Spanish manufacturing industry has experienced a major increase in the number of migrant workers in the employed population during the analyzed period (it has risen from 0.26% in 1990 to almost 2% in 2000 and to a little over 8% in 2005). The intense incorporation of immigrants in the labour force has basically favoured the expansion of the

[22] Griliches (1969)

[23] Borjas, Freeman and Katz consider that "trade, immigration and the flow of international capital" are potentially substitute strategies to make up for the lack of factors in an economy. They suggest that although empirical studies of trade and immigration have traditionally been made independently, this is not the best option if they are substitutes to change the different factors share in the national economy. Hence, they examine the impact of immigration and trade with less developed countries on the United States labour market between 1980 and 1995, finding that migrant labour explains 27-55% of the increase in the wage gap between skilled and unskilled workers, while trade accounts for 10%.

most labour intensive occupations and of those for low skills workers, so this variable is expected to be negative ($\beta_I < 0$) showing a change in employment that favours lower job categories. Moreover, migrant labour seems to be complementary to, rather than a substitute for, domestic labour: the increase in the employment rate of migrants has not led to a reduction in the employment rate of Spanish workers. The hypothesis is that immigrant employment could be being used as a substitute for offshoring strategies[24]. If that was the case, it might help explain why offshoring of production has slowed down since 2000.

As for the temporary employment ratio, since the introduction of temporary contracts by the labour legislation reform in 1984, they have undergone a considerable expansion, going from 3% of total manufacturing employment in 1984 to 30% in 1995[25]. Their main advantage for company managers is the lower cost of terminating contracts and a greater flexibility to make adjustments when fluctuations in the demand for their products occur. However, the analysis shows that the use of temporary contracts does not affect all workers in the same way. Davia and Hernánz (2004) find an inverse relation between the temporary employment rate and the professional category of workers: workers in a higher category (which correspond to our definition of non-manual workers) have substantially lower temporary employment rates than those more closely linked to physical production. The reason for this may be that manual jobs require less training, which, in turn, favours job rotation. However, company managers are more reluctant to use temporary contracts for the workers' categories that yield a higher added value per product unit and that have more skills (generally, those that are not manual) in order to retain those workers in the company. Thus, a negative sign is expected for this variable, indicating that increases in the share of temporary workers will generate a higher proportion of manual workers.

4.2 Implementation of the Model

The two specifications of the model are estimated for the 1990-2000 period and for 19 manufacturing activities (2-digit level of NACE[26] Rev.3). In order to capture the dynamic nature of the changes in the relative demand for labour, we specified a linear equation with a

[24] This hypothesis has been considered by Navaretti, Bertola and Sembenelli (2008) for a set of Italian firms. Other studies that have tried to analyze the relation of complementariness or substitutability between flows of migrant labour, foreign investment and offshoring are those by Murat and Paba (2004) also for the Italian economy; Buch et al. (2005) for Germany and Kirkegard (2005) for the USA.
[25] Alonso and Galdón (2007).
[26] Statistical Classification of Economic Activities in the European Community.

lagged dependent variable for each specification. Thus, the estimated equations have the following form:

(Specification 1):

$$\Delta\frac{L^{E}_{it}}{L^{O}_{it}}=\beta_{E}+\beta_{L}\Delta\left(\frac{L^{E}}{L^{O}}\right)_{i(t-1)}+\beta_{w}\Delta\ln\frac{w^{E}_{it}}{w^{O}_{it}}+\beta_{Y}\Delta\ln Y_{it}+\beta_{K}\Delta\ln\frac{K_{it}}{Y_{it}}+\beta_{T}\frac{(R\&D)_{it}}{Y_{it}}+\beta_{O}OFFS_{it}+\beta_{I}\Delta IMM_{it}+\beta_{T}\Delta TEMP_{it}+\Delta u_{it}$$

(Specification 2):

$$\Delta\frac{w^{E}_{it}}{w^{O}_{it}}=\beta_{E}+\beta_{w}\Delta\left(\frac{w^{E}}{w^{O}}\right)_{i(t-1)}+\beta_{Y}\Delta\ln Y_{it}+\beta_{K}\Delta\ln\frac{K_{it}}{Y_{it}}+\beta_{T}\frac{(R\&D)_{it}}{Y_{it}}+\beta_{O}OFFS_{it}+\beta_{I}\Delta IMM_{it}+\beta_{T}\Delta TEMP_{it}+\Delta u_{it}$$

However, in the estimation of these dynamic panel data models, different econometric difficulties can arise. The first one is the existence of "unobserved heterogeneity", i.e. the presence of unobserved characteristics or individual effects in the different manufacturing activities that the explanatory variables are not able to reflect. For example, a sector-specific production technology may allow the phases of the production process to be more easily dispersed than in another sector. This production technology varies across sectors but it is not expected to change very much in a short time period. The *Breusch-Pagan* test enables us to reject the null hypothesis of the absence of heterocedasticity; hence there is a need to use estimation techniques that can correct this econometric problem[27]. The second problem is the possible endogeneity of some of the regressors. In addition to that, the explanatory variables included the delayed dependent variable.

The consideration of the endogenous nature of the explanatory variables is resolved through economic logic and one's own intuition since, *a priori*, it is not easy to know which variables are endogenous. That is not the case with relative wages, which we clearly consider endogenous. Manufacturing wages and relative employment are determined simultaneously, even in a rigid labour context like the Spanish labour market. In this context, the relative wage variable cannot be considered exogenous and thus instrumental variables have to be used to control for the endogeneity and to get a consistent estimator. For other variables, like offshoring or migrant labour, the endogenous nature is unclear and hence there is no consensus in the empirical literature. The offshoring of production has been considered an exogenous variable in many empirical analyses. The justification lies in the fact that other external factors such as trade liberalization and progress in information and communication

technologies have determined the evolution of this strategy in recent years. However, in our estimation for the Spanish economy, both offshoring and migrant labour are considered as endogenous. Their endogenous nature could be defended on the basis of two facts: the greater relative demand for labour of a lower professional category could be favouring a greater use of offshoring strategies in the Spanish economy, on the one hand, and a greater attraction of immigrants, on the other. Finally, technological change will be considered as exogenous[28].

Taking all these aspects (potential industry unobserved heterogeneity, endogeneity of any of our right-hand side variables and dynamic panel data model) into account, the appropriate estimator is the System Generalized Method of Moments (GMM) developed by Arellano and Bover (1995) and Blundell and Bond (1998)[29]. We employ one-step GMM[30], using robust standard errors.

5. ECONOMETRIC ANALYSIS

The results of the econometric analysis on changes in the composition of labour (specification 1) and the wage gap (specification 2) using the Generalized Method of Moments are shown separately in Table 3.

For the employment estimation (specification 1), results in column 1 of the first model specification, which only considers the endogeneity of the relative wages, allows us to verify the significance of relative wages, real production, capital intensity, technical change and offshoring of production. In the first four variables, the signs obtained are in line with those found by the empirical literature. However, this is not the case with the offshoring variable, where the results reveal an adverse impact on *Employee* workers. In other words, the international fragmentation of production in Spanish manufacturing industry during the nineties favoured an increase in workers of lower job categories, as opposed to what happened in other developed countries[31]. This result leads us to deduce that the main direction

[27] For the specification (1): χ^2 (1)= 23,15 p(value)=0,0000; for the specification (2): χ^2 (1)= 2,81 p(value)=0,093.
[28] The empirical literature has no clear criteria when it comes to considering whether technological change is endogenous or exogenous. The studies by Geishecker (2006) and Ekholm and Hakkala (2006), among others, have also considered it as exogenous.
[29] In the presence of heterocedasticity, the estimation of the model by using the Instrumental Variables technique is not consistent while the GMM estimator remains so (Baum *et al*., 2003)
[30] The estimation can be done in two stages so that it will be asymptotically more efficient if the errors are heterocedastic. However, in the specification of our model the GMM only allows for the estimation to be done in one stage.
[31] This result is contrary to those presented by Minondo and Rubert (2006), the only estimation about the effects of offshoring on relative employment composition for Spanish industry. But we should point out the different period of analysis, 1986-1994, and the fact that the authors consider qualifications rather than job categories when distinguishing between the groups of workers affected by offshoring.

adopted by offshoring strategies in Spanish industry is different to that of more advanced countries.

As for the migrant labour variable, as was to be expected, the negative and significant coefficient shows that the increasing presence of migrant workers in the industry has led to changes in employment that favour lower job categories, in line with Hanson and Slaughter (1999) results. It should also be noted that results confirm the international trade theory, supporting the idea that the international flow of workers from less developed countries to more developed countries should generate in the latter a greater increase in labour endowments, changing their capital-labour ratio and leading to a tendency towards low wages and greater specialization in labour intensive production[32]. The absolute value of the coefficient also shows that its impact on the Spanish manufacturing labour market in the nineties was lower than that caused by the offshoring of production. To interpret this result we should keep in mind that the phenomenon of migrant labour started to gain importance in the late nineties.

The temporary employment rate, as predicted, also presents a significant and negative effect, showing that the increases in the share of temporary workers have boosted changes in employment in favour of manual employees.

In the other hand, it should be noted that, since we have adopted a dynamic specification, the econometric results for the Spanish manufacturing labour market show that the changes in the relative composition of employment are not persistent. In other words, increases in the relative demand for skilled labour in a certain year do not have any significant effect on the changes in the following period.

[32] This will, however, depend on the number of migratory flows, the relative level of qualifications of the immigrant population with respect to the national active population in the host country, and the employment rate and level of rigidity or flexibility in terms of wages, both for the labour market as a whole and for the special occupational categories.

TABLE 3: OFFSHORING AND LABOUR STRUCTURE IN SPANISH INDUSTRY

(GMM System)

(Specification 1) Dependent Variable: $\Delta (L^E / L^O)_t$				(Specification 2) Dependent Variable: $\Delta (W^E / W^O)_t$			
Parameters	(1)	(2)	(3)	Parameters	(1)	(2)	(3)
$\Delta (L^E / L^O)_{t-1}$	0.141	0.010	-0.012	$\Delta (W^E / W^O)_{t-1}$	0.217**	0.024	0.118
	(0.136)	(0.076)	(0.048)		(0.110)	(0.090)	(0.139)
$\Delta \ln (W^E / W^O)_t$	-9.466***	-7.301***	-6.744***				
	(2.597)	(2.103)	(1.928)				
$\Delta \ln Y_t$	6.054**	4.851**	4.488*	$\Delta \ln Y_t$	1.181	1.032	1.096
	(2.738)	(2.573)	(2.489)		(1.038)	(0.955)	(0.969)
$\Delta \ln (K/Y)_t$	3.345***	2.867***	2.698**	$\Delta \ln (K/Y)_t$	0.944**	0.771*	0.780*
	(1.166)	(1.032)	(1.059)		(0.500)	(0.458)	(0.467)
$(R\&D/Y)_t$	1.040*	1.000*	0.947	$(R\&D/Y)_t$	0.107	0.081	0.012
	(0.606)	(0.588)	(0.603)		(0.163)	(0.126)	(0.116)
$OFFS_t$	-0.194**	-0.264**	-0.232**	$OFFS_t$	-0.057**	-0.089***	-0.086**
	(0.087)	(0.120)	(0.098)		(0.022)	(0.032)	(0.038)
ΔIMM_t	-0.017*	-0.021**	-0.018**	ΔIMM_t	0.003*	0.003**	0.004**
	(0.009)	(0.008)	(0.008)		(0.002)	(0.001)	(0.001)
$\Delta TEMP_t$	-0.219**	-0.210**	-0.198**	$\Delta TEMP_t$	-0.024	-0.031	-0.034
	(0.097)	(0.099)	(0.099)		(0.026)	(0.028)	(0.027)
Observations		171		Observations		171	
Sectors		19		Sectors		19	
Test (*p-values*)				Test (*p-values*)			
AR (1)	0.010	0.010	0.016	AR (1)	0.004	0.006	0.004
AR (2)	0.420	0.550	0.553	AR (2)	0.631	0.725	0.977
Sargan Test	0.441	0.320	0.514	Sargan Test	0.867	0.755	0.934
Hansen Test	0.986	1.000	1.000	Hansen Test	0.999	1.000	1.000

Notes:

- Robust standard errors are shown in parentheses. * Statistically significant at 10%, ** at 5%, *** at 1%.
- AR(1) and AR(2) are first and second order tests of serial correlation. The *Sargan-Hansen* is a test of over-identification of restrictions: p-values < 0.05 involves rejecting the validity of the instruments used in the estimation. The problem of over-identification of restrictions suggests the need for a limit on the number of instruments used.

The consistence of our estimations depends on the validity of the instruments used which is verified by different tests. In this regard, the *Sargan-Hansen* test of over-identification of restrictions analyses the significance of the set of instruments used to identify the model. In our case, the test results did not reject the validity of the instruments used in the estimations. We have run other tests in order to examine the existence of first and second order serial correlation. As can be seen in the estimation results -AR(1) and AR(2)-, the null hypothesis of the absence of second order correlation was accepted.

Finally, columns (2) and (3) repeat the former estimations by considering offshoring and migrant labour, respectively, to be endogenous. We obtain very similar results to those mentioned above and this guarantees the robustness of the model.

As regards the effect of the international fragmentation of production on the wage gap between categories of workers (specification 2), the results in the right side of table 3 show that in the Spanish economy, again as opposed to other developed economies, offshoring has contributed to narrowing the wage gap between higher and lower category of workers (column 1). In this case, the migrant labour variable shows a positive and significant coefficient, hence increasing the relative wages of white-collar workers. As with specification 1, the result is similar when offshoring and migrant labour variables are considered as endogenous (columns 2 and 3).

In specification 2, it is surprising to note the lack of significance of the technical change coefficient. Because of this result, instead of R&D expenditure with respect to GDP[33], we have used a broader measure: changes in the percentage of innovative firms in relation to the total number of firms, a variable obtained from statistical information provided by the Business Strategy Survey. However, the econometric results have remained unaltered. Therefore, the technological effort made by Spanish industry in the nineties, although increased, has been an irrelevant factor to explain changes in the wage gap.

6. CONCLUDING REMARKS

According to the most common indicator for estimating offshoring of production – the increase in imported intermediate inputs in relation to industry output –offshoring has played an increasing role in Spanish manufacturing industry from 1990 to 2005, but mainly in the second half of the 1990s. In this study we have examined the implications of this strategy on the relative composition of employment and wage gaps, in order to provide further insights into the direction of offshoring strategies in Spanish manufacturing firms.

We have used GMM econometric techniques to estimate the effect of offshoring considering two types of workers, *Operators* and *Employees*, depending on their relation to the physical production of goods.

The econometric results show that in Spanish manufacturing this strategy has favoured the demand for blue-collar workers as well as it has contributed to narrowing the wage gap between white-collar and blue-collar workers in the nineties. This result is contrary to the one

[33] Since investment in R&D manufacturing activities in a certain year might have been made in a period where there is a time lag, the estimations have been made considering one and two lags of the variable. The results however have remained unaltered.

obtained in previous research for more developed countries, where offshoring has favoured high skilled labour.

In fact, these results are more in line with those obtained for Central and East European economies, and seem to indicate that Spanish manufacturing industry offers advantages in phases of production which are more manual labour intensive, mainly in medium and high-tech industries. This has happened at least until 2000, before Central and East European countries joined the EU. Therefore, in the process of geographical reorganization of industrial activity associated to the increasing international fragmentation of production processes, we can infer that global production networks are using Spain, among other reasons, because it is a low-cost location for these industries, taking advantage of its lower labour costs in the European context.

Some facts seem to support this finding. Studies on the vertical specialization in Spanish manufacturing have found a significant increase in the late nineties. From a sectoral perspective, the import content of exports has increased mainly in motor vehicles, electronic components and office machinery, where offshoring has been more dynamic[34]. These medium and high technology intensive activities have a relatively small presence in our industrial structure, and they have based their development on the attraction of foreign capital, due, among other reasons, to the relative labour cost advantages with respect to Europe[35]. It would not be too daring to say that FDI in more advanced Spanish industries, at least in a significant part of them, are the consequence of the international fragmentation of the production process. These investments have gone into the most labour intensive phases of production in our country, either for the assembly of imported intermediate goods or for their subsequent transformation.

In line with the above argument, we have to point out the lack of a strong technological capacity in Spain that could provide advantages in high tech production. As a consequence, there has been a significant increase in imports of parts and components in relation to the total imports of "machinery and transport material" (group 7 of the Uniform Classification of International Commerce – CUCI –). We should also take into account that, as noted by Yeats (2001), in the localization of the intermediate phases of high technological content industries, the differences in factor endowments and in prices of the production factors are not the main explanatory element. Other factors such as a skilled workforce, good infrastructures and

[34] Cadarso *et al*. (2007).
[35] Álvarez *et al*. (2007).

communication networks, distribution and trade channels and availability of key services could be even more important to guarantee the continuity of the value chain while meeting the required quality standards. Spain has all these factors, and actually they have been the main source of advantage for Spanish industry, especially with respect to the European area. In this respect, Spanish industry has enjoyed advantages for the relocation of parts of the production process mainly in medium and high-tech industries.

Our results also show the importance of migrant labour and temporary employment on changes in the relative demand for labour in favour of blue-collar workers.

Finally, this study has contributed to explaining some of the Spanish industry's weaknesses. Firstly, the slow growth in manufacturing productivity accounts, at least in part, for the greater importance of the stages of the productive process that yielded less added value. Additionally, the pattern of offshoring can also shed light on the higher degree of delocalization in medium and high tech industries such as transport equipment, machinery, electric and electronic machinery from 2000-2005[36]. Those were the industries where offshoring was more intensive during the nineties. But it is quite feasible that in a context of trade liberalization and European integration, this circumstance may be coming to an end. Those manufacturing sectors will try to find new localizations with lower relative cost than the ones found in the Spanish economy. According to our analysis, the character adopted by offshoring in Spanish manufacturing during the nineties has made our industry much more sensitive to the accession of Eastern European countries to the EU since this countries offer similar attractive for relocation, in addition to clear advantages in terms of lower labour costs.

[36] Myro and Fernández-Otheo (2008).

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STATISTICAL APPENDIX

Employment and relative wages ratios, by professional categories, have been obtained from the *Wage Survey for Industry and Services* provided by the *National Institute of Statistics* for the 1989-2000 period. Workers registered in the Social Security system in groups 1 to 7 are considered as *Employees* and those in groups raging from 8 to 11 are considered as *Operators*. However, this Survey does not provide information on the number of workers. Nevertheless, since it provides the average wage earnings for the total number of workers as well a for the *Employees* and the *Operators* groups, and the National Accounts provides data on sector employment, the number of *Employees* and *Operators* workers can be deduced through the following expressions:

$$(1) \qquad (w^{*} \times L) = (w^{E} \times L^{E}) + (w^{O} \times L^{O})$$

$$(2) \qquad L = L^{E} + L^{O}$$

where *w* being *wages* and *L* the number of *Employees.*

The narrow indicator of offshoring has been obtained from the input-output tables prepared by the *National Institute of Statistics*. However, the different methodology used in the most recent input-output tables available (1995-2000), based on 1995 input/output table, has required a laborious construction of the series of imported intermediate inputs over product unit for the period before 1990-1994 and also an extrapolation of the indicator until 2005 using data from the *Industrial Company Survey* (National Institute of Statistics)

Real production (at constant 1995 prices) in manufacturing activities has been obtained by deflating production at current prices by industrial price index based on 2000. The data for the production value from 1995 to 2000 is provided by the *National Accounts*. This information matches exactly the data in the input-output tables. The change in the input-output tables methodology has required us to estimate the production values for the period 1990-1994, for which we used the production data provided by the *Industrial Company Survey* and by the input-output tables, themselves for the 1990-1994 period.

The basic source for net capital stock has been the series provided by the *Fundación BBVA-Ivie* for 43 branches of activity - manufacturing industries accounted for 13 branches. However, in this study we have used a higher degree of statistical desaggregation and, at this point, we have calculated series of capital stock for some branches through the permanent inventory method using data on the gross investment of fixed capital provided by the OECD's *STAN Database for Industrial Analysis*. Once the series of stock of capital had been obtained,

we have calculated the percentages for the different branches out of their aggregate and applied the corresponding aggregate from the *Fundación BBVA-Ivie* series to obtain the disaggregate series of net capital stock. The capital intensity for 1990 to 2000 has been obtained through the capital stock ratio over the production value at constant 1995 prices.

The data for R&D expenditure have been taken from the *R&D statistics in Spain* provided by the *National Institute of Statistics*. This information details the total internal expenditure on R&D by branch of activity including running expenses (personnel costs and other running expenses) and capital costs (expenditure on equipment and instruments and expenditure on plant and buildings).

The data on migrant labour by manufacturing activities have been taken from the *Economically Active Population Survey* provided by the *National Institute of Statistics*. To deal with the limited degree of statistical desegregation, we have also used data for the percentage of foreign workers registered in the Social Security system by branches over the total number of workers registered in the Social Security system, as provided by the Spanish Ministry of Labour and Social Affairs.

The temporary employment variable has been obtained from the *Survey of Business Strategy* measured as the share of temporary workers over total employment.

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