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FUNDACIÓN DE LAS CAJAS DE AHORROS
DOCUMENTO DE TRABAJO
Nº 305/2007

De conformidad con la base quinta de la convocatoria del Programa de Estímulo a la Investigación, este trabajo ha sido sometido a evaluación externa anónima de especialistas cualificados a fin de contrastar su nivel técnico.

ISBN: 84-89116-07-5

La serie **DOCUMENTOS DE TRABAJO** incluye avances y resultados de investigaciones dentro de los programas de la Fundación de las Cajas de Ahorros.

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José Antonio Carrasco Gallego*

Abstract

In the last decade, the Spanish economy was an exception to the increasing wage inequality between skilled and unskilled workers that was widespread in the majority of the developed countries. Spain suffered, at this time, several exogenous shocks that may have influenced this different tendency.

This paper analyses the determinants of the relative wage through a macroeconomic perspective in Spain across the period 1989-98. Using panel data techniques the author finds evidence that the Trade Model, with the exogenous skilled biased technological progress as the main variable, is the model that best fits in explaining the evolution of the relative wage in the Spanish manufacturing industry from 1989 to 1998. The facts that support this affirmation are: first, it appropriately conjectures the impact of the explaining variables correctly guessing the sign of the coefficients of the explaining variables; second, the technological progress is the only significant variable, with a positive coefficient and it is exogenous; and third, even the huge increase in the relative labor supply, this variable is not significant, as predicted by the trade model.

JEL codes: F16, J31, L60, C23, J21.

Keywords: relative wage, wage inequality, skilled workers, unskilled workers, international trade, technological progress, foreign direct investment, panel data.

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1. Introduction

A common fact in the past decades in most developed countries has been the increasing wage inequality between workers with a higher level of education, so-called "skilled workers", in comparison to those with a lower investment in human capital, "unskilled workers". In the 1980's, the relative wage (RW hereafter) of skilled workers with respect to unskilled workers increased in favor of skilled workers at an average rate of 2% in Australia, 3% in Japan, 7% in Denmark and the United States, 12% in Luxemburg, and 14% in the United Kingdom (Machin 2002b).

Several scholars have provided explanations for the downward trend of the less qualified workers relative salaries through an interesting debate between the two main approaches: the labor analysis and the trade explanation. For instance, some labor scholars, like Katz and Murphy (1992), suggest that imports and the number of skilled workers can influence the RW from the relative labor supply side, and technological progress from the relative labor demand side. However, the authors of the trade point of view, Leamer (1998) among others, consider that the labor supply side has no effect on the RW, and the globalization is the main cause that influences the RW through the relative labor demand side.

Another complementary explanation of the evolution of the RW can be founded in the Feenstra and Hanson model (1996), and the related approach of Antràs, Garicano and Rossi-Hansberg (2006). This perspective focuses the effect of foreign direct investment on the RW of the host country.

Therefore, we can say that the determinants of the RW for these theories are technological progress, relative labor supply, imports, exports and foreign direct investment. This paper reviews in-depth the two main theoretical perspectives and the Feenstra and Hanson model in Section 2.

From the empirical view, some scholars have pointed out that during those years, as an exception to the common rule, one country experienced a drop in the relative wages: Spain. Abadie (1997), with a quantile regression, shows that during the

1980's there was a great decline in the returns to study in that country. Also, Castillo and Jimeno (1997) advise that the wage inequality between different qualification level workers decreased in those years. This paper, with a new macroeconomic perspective, details how the relative wage decreased in the Spanish manufacturing industry only 0.23% on average from 1989 to 1998. [1]

Of course, we need to analyze the determinants of the RW to look for an explanation for this fact. In the search, we notice that the Spanish case is especially interesting because it experienced during those years several exogenous shocks on the determinants of the RW that can help to show the influence of those determinants on the RW.

First, due to the fact that Spain joined the European Economic Community in 1986, there was an increasing participation in trade, both exports and imports, and received a rising level of foreign direct investment (through several changes in the legislation towards a free entrance of merchandises and capital). The Spanish exports over GDP augmented from 10.75% in 1987 to 18.02% in 1998 (growing 67%). The imports over the GDP increased in the same years from 15.4% to 22.17% respectively (growing 43%). The degree of openness of the Spanish economy raised 53%[2] at that time. Foreign direct investment in GDP terms multiplied by 3[3], from 1985 to 1998.

Second, the internal expenditures on Research and Development in relation to the GDP grew 47%[4], from 1986 to 1998. Buesa and Molero (2003) notice that during these years Spain reduced the technological gap with other developed countries through an increasing technological effort.

Third, the number of universities in Spain increased from 40 (30 were public and 10 private) to 72 (20 new public universities and 12 new private) between 1987 and 1998. Moreover, the number of university students from 1981 and 1991 increased

[1] For data availability, these are the years of study in this work.
[2] Data from Foreign Trade Statistic (Estadística de Comercio Exterior).
[3] Data from Spanish Central Bank (Banco de España).
[4] Data from Spanish Statistical Institute (INE).

80% while the population with age to accede to these studies only grew 10%, even when the university prices were raised between 13% and 19%.[5]

The evolution of the RW and its determinants in the Spanish manufacturing industry is deeply studied in Section 3 of this paper. Taking into account their evolution, the sign of those determinants is predicted, figuring out their positive or negative influence on the RW under each theory. In this way, I expect that the technological progress (also known as total factor productivity), exports and the foreign direct investment have a positive impact on RW; the relative labor supply a negative influence; and the effect of the imports depends on the theory that we apply: for the labor model it has a negative one but for the trade approach it has a positive impact.

In order to analyze the information about the explaining variables of the RW, the most recently developed panel data methodology, following the work of Arellano (2003), is used to solve some econometric problems. These problems include:

a. Unobservable heterogeneity, due to the fact that some sub-sectors have a very different behavior in the RW that can capture some intrinsic differentials between them.
b. Measurement errors, coming from the difficulties to construct the data base and from the homogenization of the time series;
c. Endogeneity problems in some regressors, from some authors' hypothesis about this possibility.

Section 4 describes the resolution of these troubles in this framework, and it serves as a guide to use for other applied works facing similar problems with panel data. Specifically:

a. The unobservable heterogeneity is not rejected with an F test, and the Hausman test points out that the individual effects are correlated with the explaining variables. In this case, the recommended estimator is the Within Groups estimator because it is consistent.
b. Some evidence of measurement errors is found in the case of imports, relative labor supply, and exports, and neither for technological progress nor foreign direct investment. With this problem and in presence of unobservable heterogeneity, the best option is to use a Two Steps Least Square in orthogonal deviation.

[5] In those years, the university price per student in United States was around US $3,000 per year and in Spain was around US $450. Data from Bricall et al. (2000).

c. The endogeneity was rejected by the incremental Sargan test of over-identifying restrictions.

In Section 5, the results of the econometric analysis are interpreted from an economic point-of-view and the accuracy of the signs is reviewed. For instance, the technological progress coefficient is positive and significant, providing a proof of its skilled bias. The coefficient of the foreign direct investment is positive; however, it is not significant. For imports it is positive but not significant. Exports present a positive coefficient, significant in the within group estimation. The relative labor supply has a negative coefficient and not significant, in spite of its huge increase in those years.

After these findings, the concluding remarks of the paper are presented in Section 6. In particular, there is evidence, the signs of the determinants and the non-significance of the relative labor supply among others, which can support the idea that the best explanation of the evolution of the RW in the Spanish manufacturing industry in those years comes from the trade approach. The main determinant of the RW is the exogenous and skilled-biased technological progress. Hence, the paper achieves the goal of explaining the evolution of the RW and its determinants, the influence of each of them, and the best explanation from a macroeconomic point-of-view with a panel data methodology of the RW in the Spanish manufacturing industry from 1989 to 1998.

2. Theoretical Framework

This section describes a model under common assumptions for both the labor approach and the trade explanation.[6] This model is developed under perfect competition, full employment and without any influence of labor institutions, like trade unions or minimum wage. Some authors have empirically proved the small significance of these institutions for the RW, for instance Gosling and Machin (1996) for UK, or Torres (2002) and Peraita (2003) for Spain.

[6] For a more in-depth view: Johnson (1997), Leamer (1998), Slaughter (1999), Haskel (2000) and Haskel and Slaughter (2001).

Let an economy where consumers have homothetical preferences and the total output of each sector k, Y_k, is produced with skilled labor, S_k, and unskilled labor, U_k, through a constant-returns CES production function:

$$Y_k(S_k, U_k) = \left[\alpha_k(\delta_k S_k)^{1-1/\sigma} + (1-\alpha_k)(\lambda_k U_k)^{1-1/\sigma}\right]^{\sigma/(\sigma-1)} A_k \quad (1)$$

With α_k being the extensive skilled-labor biased technological progress; δ_k the intensive skilled-labor biased technological progress; λ_k the intensive unskilled-labor biased technological progress; A_k the neutral technical parameter; and σ the elasticity of substitution, which I assume is constant and higher than one.

The unit cost function for every sector k is:

$$C_k(w_s, w_u) = \left((\alpha_k)^{\sigma} \left(\frac{w_s}{\delta_k}\right)^{1-\sigma} + (1-\alpha_k)^{\sigma} \left(\frac{w_u}{\lambda_k}\right)^{1-\sigma} \right)^{1/(\sigma-1)} (A_k)^{-1} \quad (2)$$

And w_s and w_u are wages of skilled and unskilled workers respectively.

From the first order conditions, the optimal relative demand for sector k is:

$$\left(\frac{S}{U}\right)_k = \left(\frac{\alpha_k}{1-\alpha_k}\right)^{\sigma} \left(\frac{w_s}{w_u}\right)^{-\sigma} \left(\frac{\delta_k}{\lambda_k}\right)^{\sigma-1} \quad (3)$$

Based on this equation, we can understand the main points-of-view of the two approaches below.

2.1. The Labor Explanation

This approach[7] considers only one sector in the economy[8] (*k=1*) producing the output and it has an upward slope relative labor supply curve, *(S/U)*. We make these equal to the relative demand and then total differentiating:

$$\Delta \ln\left(\frac{w_s}{w_u}\right) = \Delta \ln\left(\frac{\alpha}{1-\alpha}\right) + \frac{\sigma-1}{\sigma} \Delta \ln\left(\frac{\delta}{\lambda}\right) - \frac{1}{\sigma} \Delta \ln\left(\frac{S}{U}\right) \quad (4)$$

[7] As an example of this explanation see Berman, Bound and Griliches (1994).
[8] The labor market clears at the national level.

In Figure 1, the labor market is shown from this view: RD, the relative demand, reflects the characteristics of equation (3); RS, relative supply, assumes that the labor suppliers carry out a choice between leisure and work. The evolution of the RW in this model comes from the movements of these two curves.

Variations of RW coming from the relative demand are caused by, according to equation 4, the components of the technological change: the raise of the extensive skilled-labor biased technological progress, a; the increase in the intensive skilled-labor biased technological progress, δ; or/and the decrease in the intensive unskilled-labor biased technological progress, λ.

On the other hand, there are two reasons in the relative labor supply side which can cause changes in RW: one is the alteration in the relative skill composition of the active population; another is the imports, which include the work services of the factor more intensively used in their production. If, for instance, the relative skill composition of the active population evolves towards a more skilled level or the imports from more skilled countries are higher, then the RS will increase and the RW will decrease.

Thus, in the labor approach ***factoral biased*** changes in the demand side (technological change) and in the supply side (skill composition of the active population and imports) are decisive to study the evolution of RW.

2.2. The Trade Model

This point of view[9] is developed in the Heckscher-Ohlin (H-O) theory framework, in which it is assumed there are two sectors in a small open economy[10] ($k=2$) and the workers are perfectly mobile between these sectors. Let c be the skilled intensive sector and n the unskilled intensive sector. This means that the total wage bill of the skilled workers in sector c, V_{sc}, is higher than in the other sector, $V_{sn,}$, then: $V_{sc}>V_{sn}$.

Other assumptions are: markets are competitive; there are no barriers to international trade; prices in each sector, P_c and P_n, are exogenously determined in

[9] Two good examples of this kind of model are Deardorff (1994) and Leamer (1998).
[10] In this case, the labor market clears at the sectoral level.

international markets, i.e. this economy is small enough to have no influence on international prices; and consumers are indifferent between domestic or import goods. With these assumptions, we can derive, from equation (1), the zero profit conditions[11]:

$$P_c = C_c(w_s, w_u) = \left((\alpha_c)^{\sigma} \left(\frac{w_s}{\delta_c} \right)^{1-\sigma} + (1-\alpha_c)^{\sigma} \left(\frac{w_u}{\lambda_c} \right)^{1-\sigma} \right)^{1/(\sigma-1)} (A_c)^{-1} \quad (5)$$

$$1 = C_n(w_s, w_u) = \left((\alpha_n)^{\sigma} \left(\frac{w_s}{\delta_n} \right)^{1-\sigma} + (1-\alpha_n)^{\sigma} \left(\frac{w_u}{\lambda_n} \right)^{1-\sigma} \right)^{1/(\sigma-1)} (A_n)^{-1} \quad (6)$$

Because labor is mobile between sectors, wages are not indexed by sector.

Totally differentiating (5) and (6), and using Shepard's Lemma, we can obtain:

$$\Delta \ln \left(\frac{w_s}{w_u} \right) = \frac{1}{V_{sc} - V_{sn}} \left\{ \begin{array}{l} \Delta \ln P_c + \Delta \ln \frac{A_c}{A_n} + \left[V_{sc} \Delta \ln \delta_c - V_{sn} \Delta \ln \delta_n \right] \\ + \frac{\sigma}{\sigma - 1} \left[\frac{V_{sc} - \alpha_c}{1 - \alpha_c} \Delta \ln \alpha_c - \frac{V_{sn} - \alpha_n}{1 - \alpha_n} \Delta \ln \alpha_n \right] \end{array} \right\} \quad (7)$$

This equation shows Jones' multiplier effect[12], *[1/(*V_{sc} *-*V_{sn}*)]>1*), and the sources of variation of RW for trade approach authors:

First, the technological changes influence the RW through the zero profit conditions: if technological progress reduces relative costs in one sector, it makes the sector more profitable, and in turn the wage of the more intensive factor in this sector will increase. Consequently, in this case, ***sectoral bias*** matters.

Secondly, the international prices ratio affects imports and exports, and these have an effect on RW. If, for example, the ratio favors skilled intensive sector exports, then the demand for this sector grows. Consequently, the demand for the intensive factor of this sector increases, and RW increases, through the zero profit conditions. This is the effect of the Stolper-Samuelson Theorem. In the same way, if imports

[11] Supposing $P_n = 1$.
[12] Jones (1965).

expand in the unskilled intensive sector, the demand of the intensive factor decreases, and, therefore the RW grows. Therefore, the sectoral bias is important.

The relative demand curve defined by equation (7) is, from an accounting point of view, a weighted average of the sectors of the economy. These weights are the employment shares of each sector.

Skilled sectoral biased changes in **technological progress**, in **imports**, or in **exports** cause parallel movements in the RD curve and, consequently, increase RW. Some authors analyze the influence of the imports or exports solely through international prices. However, several scholars, for instance Feenstra (2001), have pointed out the possibility that trade positively affects innovation capacity. This is skilled-intensive and it can produce an increase in RW without a substantial change in international relative prices. As such, the stylized fact that globalization during the last decades has not implied significant changes in product prices but has affected the RW evolution can be explained. Following this point-of-view, this work, in analyzing the influence of trade in RW, looks not to the prices but to the value of exchanged merchandise.

Relative supply alterations do not induce variations in the RW. This is Rybczynski's effect[13], also named Factor Prices Insensitivity Theorem[14]. This effect explains the fact that an increase in the skilled labor supply is absorbed through a raise in the output of this economy, which is sold in perfect competition conditions in the international market. Consequently, this increase in the output affects neither the prices nor the RW. Therefore, changes in relative supply are realized through alterations in the weights of the average (RD) and in the relative quantity of skilled labor hired.

I can summarize the different conclusions of the two approaches in the following three points. First, the labor model considers a factorial bias of the determinants of RW, whereas the trade approach supposes the bias is sectoral. Secondly, the labor explanation claims imports as a relative supply determinant, but the trade model poses imports as a relative demand determinant. Finally, the labor approach asserts

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[13] Rybczynski (1955).
[14] Leamer and Levinsohn (1995).

that the alterations of the relative supply always affect the RW; the trade explanation does not consider this as a determinant of the RW.

2.3. One complementary explanation: the Feenstra and Hanson model

Between the different theoretical developments under the two previous models, it is interesting to analyze the approach of these authors[15] for several reasons. It complements the exposed theoretical framework adding a financial determinant of the RW like the **foreign direct investment** to the other real variables. In addition, after the publication of this model, interesting patterns have been extended in a similar way to explain the increase in within-worker inequality. [16]

Feenstra and Hanson basically pose capital flows from a more skilled country, called North, to a less skilled, South, to produce an intermediate good. The equilibrium in the continuum of workers by qualification, in a schematic way represented in Figure 5 by z^*, moves in both countries because of the increment of the investment towards the South, to z'. The reason given is the more skilled necessities of the capital from the North, raising the RW in the South, leaving in the North the more skilled-intensive activities that also increase the RW in the North.

Summarizing all this Section 2, the foreign direct investment together with the relative skill composition of the active population, imports, exports and the technological change, are the explaining variables that these models propose as the major reasons of the variations of RW.

3. Evolution of the Variables in Spain

After expounding on the theoretical models and deducing the explanatory factors of the RW in relation to their own hypothesis, this section looks at the alterations of the

[15] Feenstra and Hanson (1996).
[16] An example of a more general framework is the new model from Antràs, Garicano and Rossi-Hansberg (2006) regarding how globalization acts together with the state of communication technologies to shape the worldwide organization of production and the structure of rewards that sustains it.

RW and its determinants from 1989 to 1998 in the Spanish manufacturing industry. This industry is divided into 13 sub-sectors according to the NACE-CLIO R25 classification. [17]

The first two columns of Table 1 are the RW ratio of the first and last years of the sample. The third column is the variation of the RW between those two years. The average change is -0.23%. This result is in the same line as other results like Abadie (1997) or Castillo and Jimeno (1997). They showed, with other methods and different time periods, that the RW had decreased in Spain. However, in this table we can see that the performance of each sub-sector in the industry has been very different. Eight sub-sectors have negative variations and five present positive variations. Some of them have decreases down to -9.70%, and others have increases in RW up to 7.50%. These differences can be evidence of an idiosyncratic behavior in each sub-sector. In Figure 2 we can observe the average of the ratio of the RW.

The fourth column of Table 1 lists the results for the relative skill composition of the active population[18], from now on **relative labor supply**[19]. In all sub-sectors, it has increased and the average rise in the whole period is 107%. We can see the trend of this variable for the average of the manufacturing industry in Figure 3. According to the labor approach,[20] with such an increase, the sign of this variable in the regression will be negative. Some authors, for example Borjas, Freeman and Katz (1997), consider immigration as a distinct variable. In the Spanish case, in these years, it is not necessary to distinguish immigration because the immigrant population was less than 1%, and its skilled evolution was very similar to the domestic one[21]. Hence, we can contemplate the active population as a whole.

The next explaining variable is the **technological progress**. In Figure 4, we see the evolution of this variable in average for the whole industry. We can theoretically

[17] For more information about the construction of the variable series, see the Data Appendix.
[18] Employees plus unemployed.
[19] I consider the relative labor supply strictly speaking, i.e. the relative number of skilled workers over the relative number of unskilled workers in each sub-sector. Imports, also considered as relative labor supply in a broad sense by the labor perspective, have their specific treatment.
[20] The trade model considers the relative labor supply has no effect on the RW.
[21] See Carrasco (2006).

distinguish the different components of technological progress as in equation (1). However, it is not possible to do it empirically with the Spanish data. Even Haskel and Slaughter (2002) write that the necessary level of breakdown does not exist either for UK or US data. Although one may try to do it, it may be done inappropriately and bias from omitted variables or endogeneity can be committed, these authors say. In general, the technological progress[22] has increased in the manufacturing industry by 32.61%. I expect a positive sign in the regression because in other studies about Spain this variable has resulted positively correlated with RW and skilled workers biased[23] and it has risen in this period. We can check if our expectation is fulfilled when the regression runs.

In the case of the **foreign direct investment**, during these years Spain was a receiver country and, as shown in the sixth column of the Table, there was an average increase of 5.73%. As some scholars have presented,[24] this effect has a positive influence on RW, consequently I expect a positive sign for this variable in the regression. On average, this variable is represented in Figure 5.

In the seventh column of Table 1, **exports** are pointed up. We can see they have increased in all sectors with an average of 92%. However, they have increased 59% more in the skilled sub-sectors.[25] Taken into account our theoretical trade model, this fact must forecast a positive impact of exports in the RW. We can observe the trend in the next figure.

Figure 6 here.

The data for **imports** are described in the last column of the Table and in Figure 7. They have had an average increase of 46.66%. According to the labor model (factoral bias of the change), their influence will be negative because in these years

[22] See Data Appendix to study how this variable is constructed
[23] Torres (2002) and Peraita (2003).
[24] Feenstra and Hanson (1997).
[25] The skilled sub-sectors are those with ratio of skilled workers over the average of the manufacturing industry. They are Chemical products; Office and data processing machines, precision and optical instruments; Agricultural and industrial machinery; Electrical goods; Transport equipment; and Paper and printing products.

more than 80% of imports in Spain were from OECD countries.[26] This implies an increase in skilled worker services. Nevertheless, the rise of imports affected more (6.70% higher) in the unskilled intensive sub-sectors. Consequently, and according to the trade approach (sectoral influence), the sign of this variable in the regression will be positive. These dissimilarities in the sign are due to the different assumptions in both models. They can help determine which model better fits the evolution of the RW in Spain.

Once we know the historical evolution of the endogenous variable and its determinants and have forecasts about the sign of their coefficients under the different models, we next study which of those models best explains this evolution.

4. Empirical Results

As Borjas, Freeman and Katz (1997) explained, the commercial relationships and capital and labor movements are substitute ways of altering the domestic endowments. Consequently, the correct method is to analyze these variables together, rather than in different regressions. It is for this reason that in this section we study the econometric results contrasting in the same equation, with a methodology similar to that of Autor, Katz and Krueger (1998) and Machin and Van Reenen (1998), which describe how the variations of relative labor supply, technological change, foreign direct investment, exports, and imports affect the RW. Thus, the equation that we need to estimate is as follows:

$$w_{it} = \beta_0 + \beta_1 rls_{it} + \beta_2 tc_{it} + \beta_3 fdi_{it} + \beta_4 \exp_{it} + \beta_5 imp_{it} + u_{it} \qquad (8)$$

The subscripts *i* and *t* are the sub-sector (13 sub-sectors) and the year (10 years of data, from 1989 to 1998); w_{it} is the RW; rls_{it} is the relative labor supply; tc_{it} is the technological change; fdi_{it} is the foreign direct investment; exp_{it} are exports; imp_{it} are imports (all these variables are in log); and u_{it} is the stochastic error term.

[26] Ministerio de Economía y Hacienda (1998).

I adopt a panel data information structure which can solve the problems I will proceed to study. This structure combines *i =1, ..., 13* cross-section observations with *t = 1, ..., 10* time series observations. Let be β the coefficient vector and x_{it} the regressors matrix, rewriting equation (8)

$$w_{it} = x_{it}'\beta + u_{it} \qquad (i = 1, \ldots, 13;\ t = 1, \ldots, 10) \qquad (9)$$

In order to solve the econometric problems, I have followed, according to Arellano and Bover (1990) and Arellano (2003), the next 6 steps:

(First) I calculate an Ordinary Least Squares in levels (OLS) estimator. An F-test is necessary to know if unobservable heterogeneity exists. If that is the case, these estimates are unbiased but inefficient.

(Second) To achieve a more efficient estimator, a Generalized Least Squares (GLS) regression is carried out. This estimate is done supposing that the individual effects are not correlated with the explaining variables.

(Third) The Within Groups estimator (WG) is calculated under the hypothesis of correlation between the individual effects and the explaining variables.

(Fourth) In order to contrast the absence (random effects) or presence (fixed effects) of the correlation between the individual effects and the explaining variables a Hausman test is made.

(Fifth) After calculating an Ordinary Least Squares in first differences (OLS dif) estimator, I compare the results with the WG estimates. If there are great differences, it is possible that there are measurement errors causing biases. A Two-Step Least-Squares estimate (2SLS) can solve this.

(Sixth) To take care about endogeneity problems, I draw a distinction between the results of WG, OLS and 2SLS. For the suspicious explaining variables, Generalized Moment Method (GMM) estimates, and the incremental Sargan tests of over-identifying restrictions are carried out to check for this problem.

Table 2 presents the results of these different estimates. Each step is explained thoroughly in the following sub-sections.

4.1. Unobservable Heterogeneity

The different behavior of some variables in the manufacturing sub-sectors, as we see in Table 1, focuses attention on the existence of unobservable characteristics or individual effects in those sub-sectors. These individual effects capture intrinsic differences between the sub-sectors which are not reflected in the explaining variables.

(First) In column 1 of Table 2 the Ordinary Least Squares in levels (OLS) estimates are shown. With unobservable heterogeneity these estimates are unbiased but inefficient. To verify the possibility of unobservable heterogeneity an F-test is carried out under the null hypothesis of equality of the individual effects[27]. The result [F (12, 103) = 43,01] may reject the null hypothesis, which suggests the existence of individual effects.

In this case, the random disturbance, u_{it}, can be broken-down into two components: the individual effect (specific to each sub-sector and time constant), η_i, and the strictly speaking disturbance term, v_{it}:

$$u_{it} = \eta_i + v_{it} \qquad (i=1, \ldots, N;\ t = 1, \ldots, T) \qquad (10)$$

Consequently, equation (9) can be re-written as:

$$w_{it} = x_{it}'\beta + \eta_i + v_{it} \qquad (i=1, \ldots, N;\ t = 1, \ldots, T) \qquad (11)$$

(Second) If we assume neither η_i nor v_{it} is correlated with the regressors, $E[x_{it}\eta_i] = E[x_{it}v_{it}] = 0$, then we are using a random effect model and we

[27] The null hypothesis supports a restrict model which claims that the individual effects do not exist and that the intercept is unique for the thirteen manufacturing sub-sectors. This is in opposition to a model with a different intercept for each sub-sector.

estimate the equation (9). In addition, if we suppose that the expectation of the components of random disturbance is zero, $E[\eta_i] = E[v_{it}] = 0$, and there is no serial correlation, $E[v_{it} v_{is}] = 0$, then OLS in levels estimates of β are unbiased but inefficient[28] because $E[u_{it} u_{is}] = Var[\eta_i]$, $\forall\ t \neq s$. It is possible to obtain a more efficient estimator using Generalized Least Squares (GLS).

(Third) On the other hand, if we consider that there is no justification for considering these individual effects as non-correlated with the regressors, and we adopt a fixed effects approach, working with equation (11) ($E[x_{it} \eta_i] \neq 0$), then the random disturbance u_{it} is serially correlated. Thus, OLS estimates are inconsistent and spurious correlation problems could be presented.

In order to avoid this kind of problem, in the fixed effect models the Within Groups estimator (WG) is used. This Within Groups estimator is also known as fixed effects estimator, dummy-variable least-square estimator or covariance estimator, and it can be considered as an OLS in orthogonal deviations estimator. It is assumed that the individual effects are time-constant. Under strict exogeneity of x_{it} with respect to v_{it}, $E[x_{it} v_{it}] = 0$, this estimator is consistent.

(Fourth) The Hausman test[29] contrasts the dependence between the individual effects and the explaining variables. It confronts the WG estimator and the GLS estimator, under the null hypothesis of independence between the individual effects and the explaining variables, $E[x_{it} \eta_i] = 0$. The result of this test, [$\chi^2(5)$= 490,71], allows for the rejection of the null hypothesis. Then, there are individual effects and these are correlated with the explaining variables, and the WG estimator is advisable because it is consistent.

[28] Hausman and Taylor (1981).
[29] Hausman (1978).

4.2. Measurement errors

(Fifth) Considering the difficulties in the construction of data for some variables[30], there could be measurement errors. If we suppose that the true regressors are x_{it}^{+} but we observe x_{it} with a measurement error ε_{it}, then $x_{it} = x_{it}^{+} + \varepsilon_{it}$. Thus, equation (11) is

$$w_{it} = x_{it}'\beta + \eta_i + \rho_{it}, \tag{12}$$

In this equation the error term $\rho_{it} = v_{it} - \beta\varepsilon_{it}$ is negatively correlated with x_{it}. This correlation generates a positive bias because of the correlation between x_{it} and η_i, the unobservable heterogeneity studied before.

This problem can be solved with an OLS in first difference estimate, column 4 in Table 2. Nevertheless, if there is more time persistence in the systematic part than in the measurement error[31], then the error measurement bias can be exacerbated and it can double the variance. However, the WG estimator is affected with a lower bias than the first-differences estimator. Therefore, if there are significant discrepancies between the WG estimator result and those of the first-differences estimator, then measurement errors can exist. But, the WG estimates have a higher measurement error bias than OLS in levels. Hence, in order to detect measurement errors we need to compare OLS in levels, OLS in first-differences and WG estimates for each variable:

In the imports case, the OLS in levels estimated coefficient is 0.023. This coefficient can present two kinds of bias: one positive owing to unobservable heterogeneity, and another negative because of measurement errors. In the OLS in first-differences, the positive bias would disappear and the negative one would be exacerbated. We check it and this is exactly what happens because the coefficient in this case is –0.001. The WG estimate has a lower bias, with a coefficient of 0.010. These facts are evidence of the presence of measurement errors.

[30] See the Data Appendix for more details.
[31] For example, if the measurement error is white noise, Griliches (1977).

In the First-Differences estimate, the bias changes its sign. However, in the case of the relative labor supply, with a negative coefficient (-0.055), the negative measurement error bias changes to positive[32]. This bias is aggravated in the first-differences estimate and it causes the coefficient for the relative labor supply finally to be positive at 0.007. In the WG estimate, with a lower error measurement bias, the coefficient is 0.024, totally consistent with the existence of measurement errors.

Looking to exports estimates, we observe that they present a pattern close to the relative labor supply. Their coefficient in OLS in levels is negative, -0.057, and the possible measurement error bias is positive in the OLS in first-differences estimate, with a coefficient of 0.009. In the WG regression we would think that this bias would be lower, but it is not, and the coefficient is 0.043.

In the case of technological progress and foreign direct investment, the three estimates are very similar and there are no indications of measurement errors.

In order to solve the measurement error bias in imports, in relative labor supply, and, less categorically, in exports, I use a Two-Step Least-Squares estimate (2SLS).[33] In the first step, the explaining variables are regressed to some instrumental variables. In the second step, the dependant variable is estimated to the previous step dependant variables. To consider a valid instrumental variable, it has to fulfill two conditions: it may not be correlated with the random disturbances of the model, $E\left[z_{it}\rho_{it}\right]=0$; and it must be correlated with the explaining variables, $E\left[z_{it}x_{it}\right]\neq 0$. The lagged dependant variables, fulfilling these conditions, can be an option.

A 2SLS in orthogonal deviation (because of the demonstrated unobservable heterogeneity) estimate was made using as instruments the lagged values of those variables with measurement errors. With this estimate we control unobservable heterogeneity and measurement errors. The results are shown in column 5 of Table 2. The coefficients of the variables without measurement errors do not change a lot

[32] The negative measurement error bias is multiplied by the coefficient of the explaining variable. In this case, this coefficient is negative; then, the bias becomes positive.
[33] The correlation between the error terms decreases when the period of estimates increase. The optimal would be a long time series, but the data restriction does not allow for this possibility. However, Torres (2002) considers that thirteen years' time is a long time series.

with respect to OLS in levels. However, the coefficients of the variables with measurement errors have been altered: in the relative labor supply case, the measurement error bias decreases with respect to OLS in first-differences, obtaining a coefficient of -0.038; the exports coefficient is 0.038 far from OLS in its level and in its first-differences but, close to the WG estimate, indicating that the true value of exports is positive and the measurement error bias is negative and it is decreasing their true value. In the imports estimates, with 0.030 coefficient, we can check that the measurement error bias has been reduced when looking to OLS in level and in first-differences estimates.

However, in the 2SLS(a) there is a problem. The statistics of first and second order serial correlation, *m1* and *m2* respectively, are asymptotically distributed as a Normal (0,1) under the null hypothesis of non autocorrelation. They are calculated with the first-differences residuals, except for OLS in levels. Their results are consistent with the presence of individual effects in OLS in levels because they show positive autocorrelation in their residuals. When controlling the individual effects in the OLS in differences and WG, we observe that both statistics indicate negative autocorrelation. In order to obtain errors in levels not autocorrelated *m1* should be significant but not *m2*[34]. Looking at the 2SLS(a) we can check that *m2* is significant; thus, there is evidence for serial correlation. With the purpose of solving this problem we have dispensed with foreign direct investment, which is not significant in any case and does not contribute to the regression, and introduced one lag in the technological progress.[35] With these modifications the results of *m1* and *m2* prove that serial correlation does not exist.

4.3. Endogenous explaining variables

(Sixth) Several scholars have pointed out the possibility that some explaining variables are not strictly exogenous. With predetermined regressors:

$$E\left[x_{it} v_{is}\right] = 0 \,, \qquad \forall\, s \geq t$$

[34] Arellano (2003) page 121.
[35] The economic justification of the lag in technological progress is very simple: it is possible that the influence of this variable on RW works with one period of delay. In other words, the variation of the R&D investment in the *t* period influences the RW in the *t+1* period.

If this is confirmed, then the WG estimates of the variables with endogeneity problems are biased but asymptotically unbiased. However, being T finite, this problem makes the estimates biased and inconsistent.[36]

With the aim of studying the endogeneity problems in the explaining variables, we compare the results of the WG estimates with the OLS in levels and with 2SLS ones in Table 2. In the cases of relative labor supply and imports, their coefficients are lower in absolute value in WG estimates with respect to the OLS in levels and with 2SLS(a) [37] estimates. This fact generates some suspicion about the strict exogenetiy of these variables.

I make estimates following the Generalized Moment Method (GMM) in orthogonal deviations, to control the unobservable heterogeneity, in those variables with suspicion and also in technological progress, because some authors consider the endogenous character of this variable[38]. So in order to check the endogeneity problem of these regressors, I compare the incremental Sargan tests of over-identifying restrictions under strict exogeneity and under pre-determination in Table 3.

Under strict exogeneity, the GMM estimates are based on the following vector of $[T(T-1)]\times 1$ moments using present and future values of the instruments

$$b_e = \sum_{i=1}^{N} \begin{pmatrix} z_{i1} \\ z_{i2} \\ \ldots\ldots \\ z_{iT} \end{pmatrix} \otimes \begin{pmatrix} \Delta w_{i2} - \beta \Delta x_{i2} \\ \Delta w_{i3} - \beta \Delta_{i3} \\ \ldots\ldots\ldots\ldots \\ \Delta w_{iT} - \beta \Delta x_{iT} \end{pmatrix}$$

being z_{it} the instruments. Under pre-determination, GMM uses the vector of $\left[\sum_{t=1}^{T}(T-t)\right]\times 1$ moments written below and which is a subset of the previous vector:

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[36] See footnote 38.

[37] I use the results of this estimate because they are directly comparable with the others and, as we will check, the endogeneity tests do not change any previous estimate.

[38] Beaudry and Green (2002) or Acemoglu (2002) among others believe that an increase in the relative labor supply can cause the adoption of productive techniques taking advantage of the relative abundance of this production factor.

$$
b_p = \sum_{i=1}^{N} \begin{pmatrix} (z_{i1})(\Delta w_{i2} - \beta\ \Delta x_{i2}) \\ \begin{pmatrix} z_{i1} \\ z_{i2} \end{pmatrix} (\Delta w_{i3} - \beta\ \Delta x_{i3}) \\ \cdots\cdots\cdots \quad \cdots\cdots\cdots \quad \cdots\cdots\cdots \quad \cdots \\ \begin{pmatrix} z_{i1} \\ \cdots\cdots \\ z_{iT-1} \end{pmatrix} (\Delta w_{iT} - \beta\ \Delta x_{iT}) \end{pmatrix}
$$

The six columns show the results of the three couples of estimates (a couple for each suspicious variable). In the odd columns are the estimates under strict exogeneity using the present and future values of the instrumental variable. In the even columns, the variables are considered as pre-determined and only the previous values of the instrumental variable are utilized.

The results indicate that the hypothesis of strict exogeneity is accepted in all the cases, for a 1% level of confidence. This can be checked looking at the difference between the Sargan tests for each variable. Knowing the moments in the b_p vector are a subset of the b_e moment vector, if the additional 45 moment restrictions of the last vector are valid, then the difference in the Sargan tests is distributed as a χ^2 with 45 degrees of freedom. The difference in the values of the Sargan tests serves to contrast the null hypothesis of strict exogeneity. All belong to the acceptance region: for the relative labor supply this is 41 (= 83-42); for technological change is 38 (= 96-58); for the exports, it is 46 (= 91-45); and for the imports, 54 (= 95-41).

Summarizing, in the data we have evidence of unobservable heterogeneity; measurement error problems in imports, relative labor supply and exports; and we can accept the hypothesis of strict exogeneity. In the next section, these results are interpreted from an economic point of view and I analyze which of the approaches can best explain the evolution of RW in Spain.

5. Economic Interpretation

Looking at Table 2, the high value of R^2 statistic in the WG estimate stands out. This estimate explains 87% of the variation of the RW. The reason for the high R^2 is that the individual effects are reflected in this estimate through a different intercept for each manufacturing sub-sector. With this, the idiosyncrasy of the sub-sector (such as collective bargaining, trade unions power, etc.) can be better explained. If we study the coefficient of the different regressors we can see that the technological progress has a positive influence on RW of 3.7%,[39] and it is statistically significant. Exports also have a significant and positive influence of 4.3%, as forecasted by the trade approach. The other explaining variables are not significant but the Wald statistic accepts the joint significance of the regressors.

Nevertheless, with attention to econometric rigor, even if the fit is lower (20%), we should study the 2SLS(b) in orthogonal deviation –column 6 in Table 2- because of the evidence for unobservable heterogeneity, measurement errors in some variables, and the strict exogeneity which I have explained previously. This estimate stresses the following facts:

The technological progress is the only significant variable with a positive sign. This indicates that, as I have suggested before, technological change is skill biased in the manufacturing sector in Spain from 1989 to 1998. In all estimates, this variable has presented a high level of significance, and in the 2SLS(b) we can see that it has an influence on RW of 5.8%. The other variables are joint significant looking to the Wald statistic of joint significant but they are not individually. Taking this into account, we can continue to interpret the results.

The positive sign of the coefficient foreign direct investment[40] implies that capital from abroad would mean a demand for more skilled workers, improving the RW. This is the forecasted sign by the Feenstra and Hanson model. Noticing that the influence of the foreign direct investment is minimal (0.1%) and that it is not significant, this model does not properly explain the variation of the RW in the Spanish manufacturing industry in those years.

Exports have a positive coefficient of 1.6%, the expected sign by the trade approach. This influence indicates that the export sub-sectors are skilled intensive and their expansion has benefited the RW.[41]

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[39] All variables are in natural logarithms.
[40] In the 2SLS(a) regression.
[41] Keep in mind that the exports were positive and significant in the WG estimates.

We need to remember that the labor model forecasts a negative sign for the imports whereas the trade approach expects a positive one. The coefficient is positive (2%). Accordingly the trade explanation is correct: the more unskilled sub-sectors have been damaged because of increasing imports, the unskilled labor demand decreased, and the remuneration of its most intensive factor of production fell down. Consequently, imports in the Spanish manufacturing industry are a demand factor, as the trade model projects.

The relative labor supply has a negative coefficient of -1.9% but it is not significant. In the trade model, with a perfectly elastic relative labor demand, the variations of the relative labor supply have no influence in the RW. In these years, the relative labor supply increased on average 107.16%. In spite of this high rise, this factor is not statistically significant, suggesting a perfect elastic relative labor supply and contributing new evidence in favor of the trade model.

6. Conclusion

This paper presents the main theoretical approaches to wage inequality, the labor and trade explanation, and a complementary model by Feenstra and Hanson, applied to the Spanish manufacturing sub-sector. The labor model, which emphasizes factor bias, considers determinants of the RW to be imports and skill composition of the active population, in the relative labor supply side, and the technological progress, in the relative labor demand side. The trade approach supposes that the supply side has no influence on the RW and, through the sectoral bias, the demand side determinants of the RW are technological progress, exports and imports. The Feenstra and Hanson model adds the foreign direct investment as a demand side determinant.

In the Spanish manufacturing industry, the explained variable, the RW, altered on average -0.23% from 1989 to 1998[42]. The average RW ratio (1.57) is similar to those in other countries over these years when the inequality did not increase or

[42] Remember that Abadie (1997), with a quantile regression approach, finds also a decrease in the returns to schooling during the 1980s.

increased very little.[43] However, we can observe a very different behavior in the RW between the manufacturing sub-sectors reflecting some idiosyncratic characteristics.

Studying the determinants of RW, we can see that the relative labor supply increased 107% on average; the technological progress raised 32.61% on average; the foreign direct investment has increased 5.73%; the exports experienced an increase of 92%, but it was 59% more intensive in the skilled sub-sectors; and the imports grew 46.66%, and 6.70% higher in the unskilled sub-sectors.

When I analyze the relationship between the explaining variable and the regressors, three main econometric problems arose: unobservable heterogeneity, measurement errors, and endogeneity in the explaining variables. In order to solve them, the paper presents an accurate application of the panel data methodology that can be used as a guideline in similar examples. After the econometric reasoning, the chosen estimate is 2SLS in orthogonal deviations controlling for unobservable heterogeneity and measurement of errors. The endogeneity hypothesis was rejected.

In that estimate, the skilled technological progress, with a coefficient of 5.8%, is the main significant variable (in other estimates exports were also significant). This coefficient is similar to other estimates with panel data analysis made by Machin (1996), with a coefficient of 6.5% for United Kingdom; or Machin and Van Reenen (1998) with 3.7% for Japan, 3.6% for Sweden, or 2.4% for Denmark. Torres (2002) and Peraita (2003) also found evidence of skilled technological change in Spain during previous periods.

The high growth of the relative labor supply in this period (107%) reflects the fact that the Spanish active population became more skilled, which is also pointed out in several studies[44]. In spite of this strong increase, it has no influence on the RW. This is strong evidence in favor of the trade model, which shows that the relative labor demand is perfectly elastic with respect to the relative skilled workers.

Exports, imports and foreign direct investment have no influence on the RW in the 2SLS estimate, although exports have in the WG estimate. These results coincide with Autor, Katz and Krueger (1998) for the United States who also did not find

[43] Machin (2002a).
[44] Bover, Bentolila and Arellano (2000), Torres (2002), and Peraita (2003).

influence of the foreign direct investment and imports on the RW. They confirmed that exports had increased more in the skilled sectors, but they were not an important factor in the RW evolution as is the skilled technological progress. This is exactly the same result that this paper shows. In the same way, in the Spanish case, Bover, Bentolila and Arellano (2000) observed that the technological progress increased the earnings of all workers, but exports and imports were not significant.

In summary, this paper, through a macroeconomic approach, finds evidence that the trade model, with the exogenous skilled biased technological progress as the main variable, is the model that best fits in explaining the evolution of RW in the Spanish manufacturing industry from 1989 to 1998. The facts that support this affirmation are: first, it appropriately conjectures the impact of the explaining variables correctly guessing the sign of the coefficients of the explaining variables; second, the technological progress is the only significant variable, with a positive coefficient and it is exogenous; and third, even the huge increase in the relative labor supply, this variable is not significant, as predicted by the trade model.

Further research can include specific variables to control the idiosyncratic characteristics in the Spanish manufacturing sub-sectors in order to explain the high significance of the individual effects on the WG estimates and as a way to include labor market institution that, based in previous studies conclusions, are not include in this paper.

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Data Appendix

In this Appendix the main characteristics of the data used in the paper are explained.

Let us start with RW. In Spain, as in many other countries, there is no optimal classification in the statistics for workers as either skilled or unskilled. I use the taxonomy of Spanish Statistical Institute (INE) which divides production workers from non-production workers in its Wage Survey (Encuesta de Salarios) because of its higher sectoral breakdown. Generically known as "Encuesta de Salarios" (ES) has had, during the studied period, two names: "Nueva Encuesta de Salarios" (NES), from 1989 to 1995, and "Encuesta de Salarios en la Industria y los Servicios" (SIS) from 1995 to 1998. These two surveys present two different classifications for the manufacturing industry: CNAE-74 and CNAE-93. A process to homogenate the data was made, in order to convert these classifications into a third one (NACE-CLIO R25). The last classification was chosen because the conversion was easier to this one at the two-digit level. This was the highest breakdown available in all the data. A deep description of this process is shown in Carrasco (2006). This classification and equivalent for other countries has been used by several scholars, either in the Spanish field[45] or in the international framework.[46] As Haskel and Slaughter (2001) have pointed out, although we can find skilled and unskilled workers in both groups of workers, on average the group of production workers presents a lower ratio of skilled over unskilled workers. This is the inverse of the non-production workers group. Berman, Bound, and Griliches (1994) and Sachs and Shatz (1994) contribute with evidence showing that, in practice, this division picks up the difference between skilled and unskilled workers. The RW ratio is calculated by dividing the average yearly wage of non-production workers by the average yearly wage of production workers.

The series of the variable relative labor supply, strictly speaking, is constructed with data from the Spanish Active Population Survey (Encuesta de Población Activa (EPA)) by INE. In this survey, the active population, employees plus unemployed, is divided into 5 levels of studies: illiterate people and those without any education, primary school, high school (except technical school), technical school, and, universities and others. I have considered unskilled workers to be in the first three groups and skilled workers to be in the last. The same aggregation is used in other papers like Minondo (2000) or Canals (2006). Finally, I divide, for each sub-sector and year, the skilled workers by the unskilled workers to build the relative labor supply.

The technological progress is measured through the R&D expenditure of each manufacturing sub-sector weighted by its value added. The information for the R&D expenditure comes from "R&D Expenditure 35 years of History" of the INE. In the

[45] Minondo (2000) and Torres (2002), for instance.
[46] Sachs and Shatz (1994), Haskel and Slaughter (2002), and Machin (2002b), among others.

case of the value added, the National Account of Spain (Contabilidad Nacional de España) of INE is used. In the years 1989 to 1998, the National Account of Spain uses two different bases: 1986 and 1995, with different classifications for the manufacturing industry. A double process to homogenate all the data coming from this source was also implemented.Machin and Van Reenen (1998) and Bover, Bentolila and Arellano (2000) are some examples of scholars that use the same ratio to approximate the technological progress.

The data to construct the foreign direct investment series come from Muñoz-Guarasa (1999) and from the Registry Office of Foreign Investment of Ministry of Industry of Spain and are also weighted by the value-added of each year and sub-sector, as Feenstra and Hanson (1996) do. Since also these sources use CNAE-74 and CNAE-93 classifications, then I needed to homogenate data.

Exports and imports are built in the same way, using data from the National Account of Spain. It is also weighted by the value-added. Other scholars who used this sort of series are Autor, Katz and Krueger (1998) and Torres (2002).

Given the complexity of constructing all these series and the data availability for all the variables, the ten years period, 1989-1998, was the maximum period of common and available data for the six variables. For higher details about the period and the construction of the series see Carrasco (2006).

Figure 1. Movement of the Equilibrium in the Intermediate Good Production in the North and in the South.

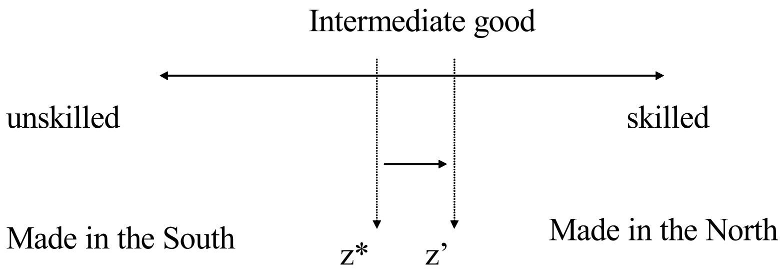

Figure 2. Average of the RW in the Spanish manufacturing industry

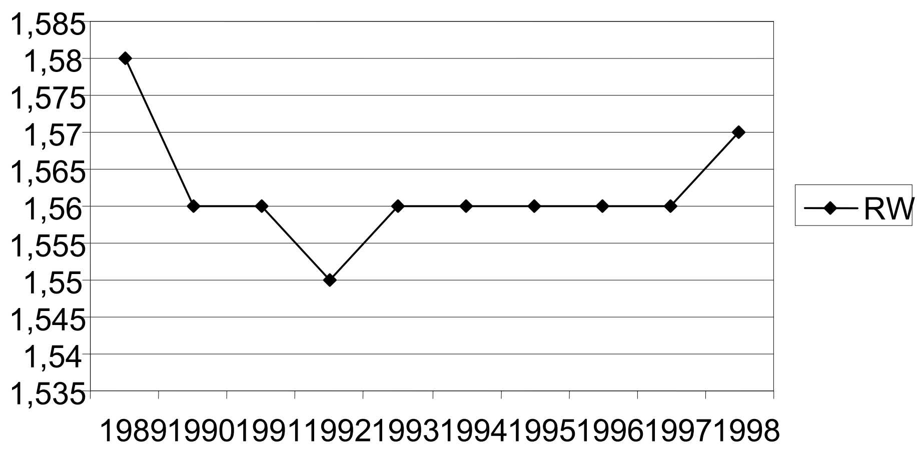

Figure 3. Average of the ratio of skilled/unskilled workers in the Spanish manufacturing industry

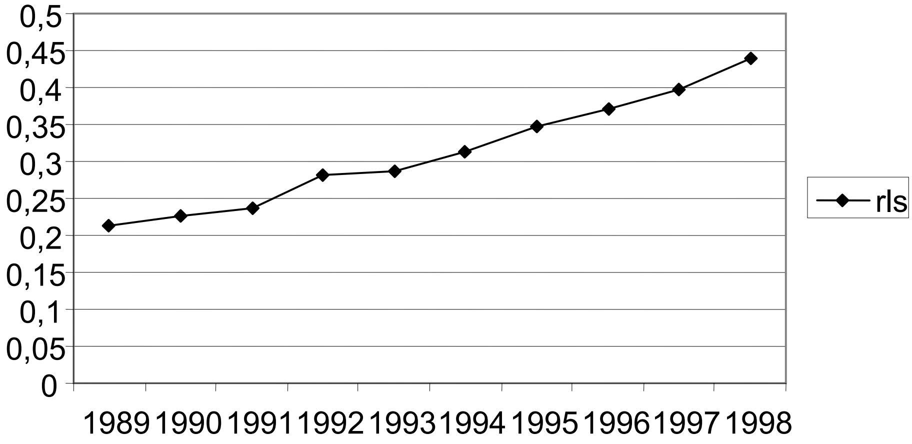

Figure 4. Average of R&D expenditure, weighted by the value added, in the Spanish manufacturing industry (%)

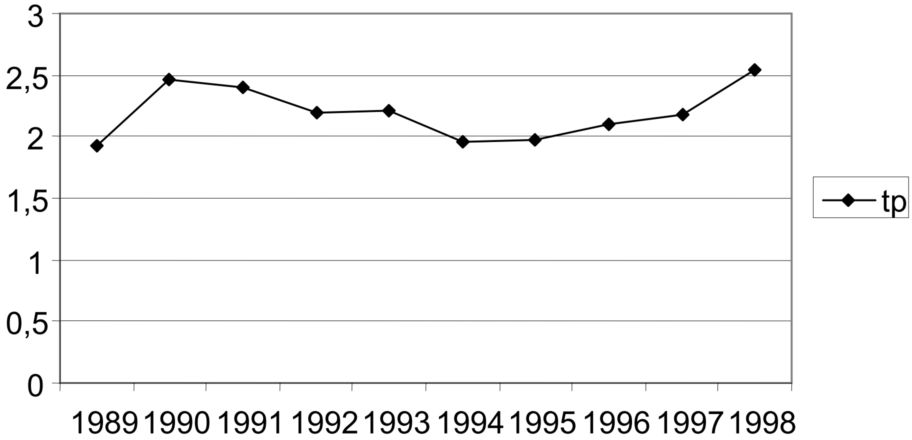

Figure 5. Average of FDI, weighted by the value added, in the Spanish manufacturing industry (%)

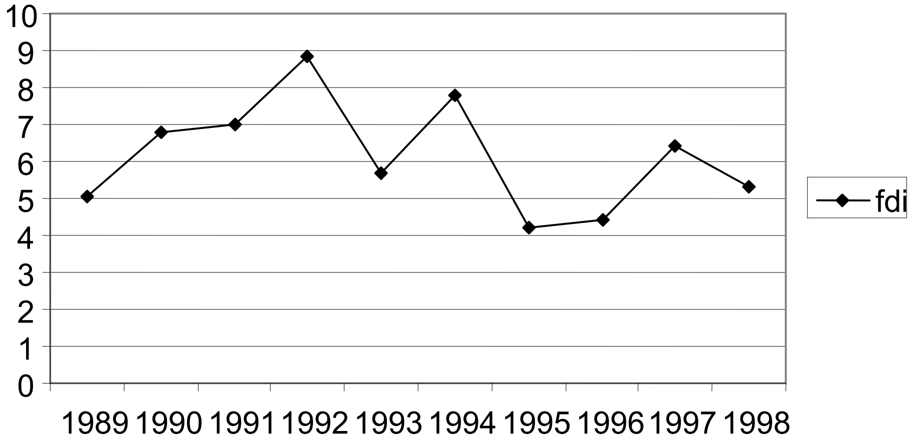

Figure 6. Average of Exports, weighted by the value added, in the Spanish manufacturing industry (%)

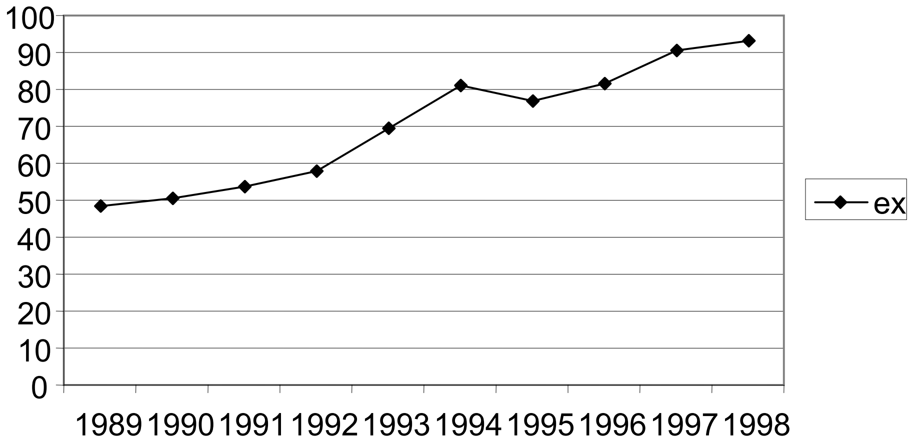

Figure 7. Average of Imports, weighted by the value added, in the Spanish manufacturing industry (%)

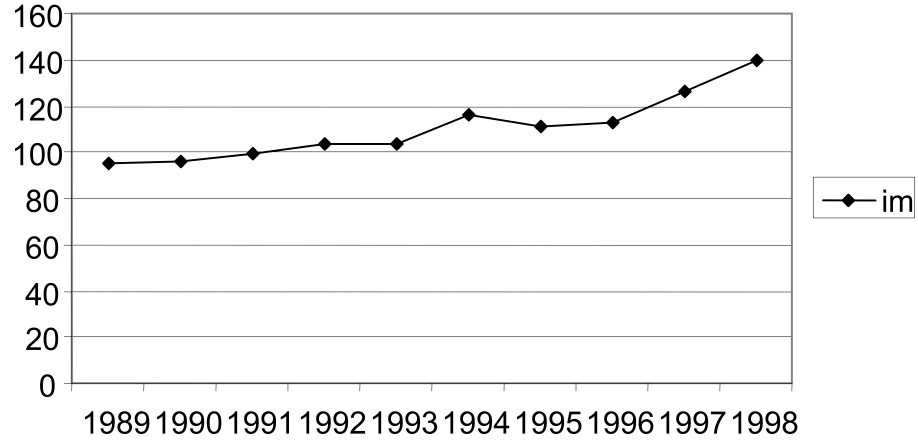

Table 1. Evolution of the variables in the Spanish manufacturing sub-sectors, 1989-98.

	rw_{1989}	rw_{1998}	Δ%rw	Δ%rls	Δ%tp	Δ%fdi	Δ%ex	Δ%im
Office, data, precision & opt. inst.	1.94	1.75	-9.70	318.78	-59.22	479.93	80.12	22.00
Rubber and plastic products	1.58	1.52	-3.43	127.34	55.65	26.95	94.49	90.11
Agricultural & industrial machin.	1.50	1.45	-3.32	110.13	-43.90	-41.24	33.71	-14.52
Chemical products	1.60	1.55	-3.05	107.15	39.37	5.18	103.40	84.38
Paper and printing products	1.44	1.42	-1.84	76.73	343.14	-76.10	19.54	19.32
Metal products	1.46	1.44	-1.30	74.70	501.27	-43.90	58.58	44.34
Other manutactured products	1.59	1.57	-1.30	81.50	317.17	207.49	71.17	46.23
Textiles, cloth., leather, footwear	1.68	1.66	-0.69	109.67	392.06	-54.50	101.13	128.58
Ferrous & non-fer. ores & metals	1.42	1.44	1.55	15.53	-33.34	844.88	69.95	102.54
Transport equipment	1.45	1.48	2.15	99.75	13.24	36.73	89.99	44.01
Food beverages, tobacco	1.58	1.67	5.08	133.17	72.14	-24.14	166.79	101.66
Non-metallic minerals & minl pd.	1.61	1.73	7.33	133.73	170.99	-78.01	91.84	34.60
Electrical goods	1.58	1.70	7.50	116.07	108.38	-7.81	315.28	104.19

Average	1.57	1.57	-0.23	107.16	32.61	5.73	92.28	46.66

Source: Author's calculations.

Table 2. Econometric results.

	OLS	GLS	WG	OLS dif	2SLS(a)	2SLS(b)
constant	0.46 (6.11)**	0.56 (9.71)**	0.028 (2.43)**	-0.016 (2.55)**	0.011 (0.56)	0.019 (0.90)
rls	-0.055 (1.41)	0.038 (2.11)*	-0.024 (1.26)	0.007 (0.60)	-0.038 (0.90)	-0.019 (0.47)
tc	0.033 (1.33)	0.033 (4.20)**	0.037 (2.63)**	0.040 (4.41)**	0.037 (2.94)**	0.058 (2.62)**
fdi	-0.003 (0.36)	0.001 (0.24)	-0.0001 (0.017)	-0.002 (0.31)	0.001 (0.14)	
exp	-0.057 (1.21)	0.027 (1.11)	0.043 (1.73)*	0.009 (0.33)	0.038 (0.92)	0.016 (0.49)
imp	0.023 (0.56)	-0.002 (0.11)	0.010 (0.32)	-0.001 (0.03)	0.030 (0.55)	0.020 (0.39)
R^2	0.24	0.10	0.87	0.11	0.26	0.20
R^2 ***adjust.***	0.14	-0.008	0.84	0.01	0.18	0.13
m1	2.52	-	-2.29	-2.20	-2.31	-2.30
m2	2.36	-	-2.45	-2.48	-2.46	-0.57
Wald conj.	4.32	-	82.85	100.95	41.32	53.77
Wald fict.	16.84	-	57.22	66.94	15.85	81.18

All estimates include time dummy variables. All tests are robust to heteroskedasticity. The results of t-statistic are in brackets, with two asterisks which are significant at 1% level of confidence, and one asterisk at 5% level. Author's calculations.

Table 3. GMM estimates in orthogonal deviations.

	rls ex.	rls pre.	tc ex.	tc pre.	imp ex.	imp pre
constant	0.034 (2.32)*	0.029 (1.32)	0.02 (1.91)	0.034 (1.53)	0.029 (2.11)*	0.054 (2.70)**
rls	-0.021 (0.97)	-0.040 (1.14)	-0.028 (1.24)	0.003 (0.12)	-0.021 (0.96)	0.030 (0.81)
tc	0.041 (3.90)**	0.059 (2.50)*	0.038 (4.23)**	0.041 (3.16)**	0.038 (4.16)**	0.043 (3.37)**
fdi	0.006 (0.98)	0.003 (0.36)	0.002 (0.34)	-0.001 (0.18)	-0.001 (0.16)	-0.001 (0.14)
exp	0.057 (1.81)	-0.003 (0.06)	0.043 (1.53)	0.024 (0.63)	0.045 (1.64)	0.078 (2.00)*
imp	-0.003 (0.11)	0.08 (1.49)	0.008 (026)	0.016 (0.30)	0.010 (0.34)	-0.025 (0.37)
Sargan h(d.f.)	83 (85)	42 (40)	96 (85)	58 (40)	95 (85)	41 (40)

All estimates include time dummy variables. All tests are robust with respect to heteroskedasticity. The results of t-statistic are in brackets, with two asterisks which are significant at 1% level of confidence, and one asterisk at 5% level. Author's calculations.

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