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Pisa, M. Isabel and Sánchez, Rosario

ESIC Business and Marketing School, University of Valencia

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Mª Isabel Pisa[2] and Rosario Sánchez[3]

Abstract:

Work incentives are closely related to production performance. This paper presents evidence that the value added of a firm increases when relative labor costs rise, or the level of unemployment increases. Both circumstances imply evidence in favor of the efficiency wage model. This theory is consistent with the views of many managers and personal administrators, who tend to ascribe primary importance to wage setting as an incentive to increase effort. We use a micro panel data set of Spanish manufacturing firms, during the period 2004–2009, to simultaneously estimate a stochastic frontier of a firm's value added and the inefficiency determinants. The data source is published in the Spanish Industrial Survey on Business Strategies (Encuesta sobre Estrategias Empresariales, ESEE), collected by the Fundación SEPI.

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Key words: efficiency, value added, labor economic, industrial relations.

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[2] ESIC Business and Marketing School, Departamento de Economía. Avda Blasco Ibañez, 55 Valencia 46018, Spain. Tel +34 96 361 4811; e-mail : Mabel.pisa@esic.edu

[3] Universidad de Valencia .Departamento de Análisis Económico. Campus dels Tarongers, Avda. Dels Tarongers s/n, 46022 Valencia, Spain. Corresponding author e-mail: rosario.Sánchez@uv.es, Tel:+34 963828252;

1. Introduction.-

The greatest problem faced by the Spanish economy is the high level of unemployment. During the period of economic growth that lasted from 1995 to 2007 the Spanish economy created a large number of jobs, only for them to be destroyed as easily as they had been created when the financial crisis began. Unemployment has grown uncontrollably, reaching 18% in 2009 and it is currently close to 26% of the active population. This dramatic increase in unemployment is due fundamentally to the destruction of a large number of jobs with scarce added value, which was reflected in the low levels of productivity of the Spanish economy. The urgent need to create new jobs and the pressure exerted on Spain by international organisations were the motivating forces behind the recent reform of labour law, the fundamental objective of which was to make the labour market more flexible by cheapening redundancies and weakening the negotiating power of Trade Unions. Since the beginning of the crisis the real value of salaries has fallen drastically, but this fall has not been accompanied by a corresponding drop in the profit margins of businesses, and for this reason the measures adopted in the recent reforms have been perceived as unjust by the majority of the workers.

These circumstances affect and shall undoubtedly continue to affect the quality of work. If the real value of salaries continues to fall then Spanish businesses will be unable to attract well-qualified workers. In fact, it will have the opposite effect, and we are already witnessing a process of de-capitalization caused by the forced exodus of highly-qualified workers to other European countries, as they have not had the opportunity to pursue their professional careers in Spain, either because there were no jobs available for them, or because the jobs that did exist did not adequately remunerate them for their level of training and expertise. The training these people received has been financed by Spanish society, but despite having assumed this cost, it will not see its benefits.

The persistence of a high level of involuntary unemployment contradicts the traditional microeconomic analysis of this type of situation. Why has the high level of competence among the unemployed not provoked a reduction in salaries sufficient to cause a drop in unemployment? There are many reasons why the labour market cannot function as a competitive market. We shall explain those that are, in our opinion, the most relevant. The social dimension of salaries makes it difficult for them to carry out the equalising role with respect to supply and demand that conventional economic theory attributes to prices in the market place. The existence of ethical norms in the labour market that condition the actions of the agents operating within it, impede purely optimizing behaviour. Time plays a far more important part in the function of the labour market than is recognised by the basic, extemporal model of supply and demand. Furthermore, what is exchanged in the labour market is not the "work" that will be used in the production process, but rather the "inclination to work". The conversion of this capacity into work effectively carried out is a problem that businessmen face daily, as an integral and inseparable part of the production process. This is evidenced by both the habitual systems of incentives and bonuses that businesses use and by the need to supervise, in one way or another, the work done. While this is self-evident to social commentators, it has a perturbing effect on the competitive model of the labour market.

The objective of this paper is to provide empirical evidence in favour of adjusting retributions to the efficiency of a firm. We provide evidence to suggest that above average labour costs increase the productivity of workers and therefore their efficiency. In this sense, higher relative labour costs are able to attract a better group of workers within the industrial sector. Labour costs include not only the salary paid to workers, but also social security payments and payments in kind, among other forms of retribution. Therefore, a systematic policy of reducing labour costs may lead to a poorer selection of workers for the firm, that is, in the same way that the price of a product reflects its quality, the salary of workers ought to reflect the quality of work. It is important to distinguish between labour costs per worker and labour costs per unit of production, because what is relevant here is what firms are able to produce by paying these labour costs. The introduction of new technologies and managerial decisions regarding the innovation of production processes and products are extremely important in order to guarantee a high level of competiveness and efficiency in the long term. The Spanish model of production that has been based fundamentally on construction and speculation distorted the system of business incentives that aim to achieve a greater level of technical and economic efficiency. Now there is a hurried attempt to regain competiveness by reducing labour costs, without any apparent awareness that these measures may damage our level of efficiency in the medium and long term.

The rise in unemployment during the period from 2007-2009 has produced an increase in the technical efficiency of businesses. This result, together with that mentioned in the preceding paragraph is coherent with the existing models of salary efficiency. The enormous level of unemployment that the Spanish economy is experiencing has meant that a high percentage of the population are in a situation of social exclusion. The fear of being forced into this group undoubtedly raises the costs of redundancy for workers, and they are obliged to increase their efforts at work and to accept negative changes in their circumstances, such as a decrease in redundancy payments and a reduction in their salary negotiating power. However, some firms are unwilling to decrease salaries because a reduction in salaries negatively affects production. The models of efficiency wages are able to explain this relationship between salaries and the effectiveness of work. A high level of unemployment increases the effectiveness of work as the worker increases his/her effort because he/she is aware of his/her reduced probability of finding new employment if fired from his/her present job for lack of effort (Shapiro y Stiglitz, 1984). In the sociological model posited by Akerlof

(1982), firms are able to augment the efforts of their workers by paying them a salary higher than the average market salary, but with the implicit condition that the workers will reciprocate by working harder than the minimum effort required by their employees. Industry and occupation variables where found to be relatively important explanatory variables for variation in earnings. Murphy and Topel (1987) also used longitudinal data, and produced different results from those obtained by using cross-section data.

In Spain studies by Sánchez and Toharia (2000) provided evidence on the testable implications of efficiency wages, productivity and the composition of the labour force; Martín-Marcos and Suárez-Gálvez (2000) analysed the existence of technical inefficiency of production in the Spanish manufacturing sector. Others focused on particular determinants of efficiency; for instance, Delgado et al (2002) centred on the relation between efficiency and exports while Díaz and Sánchez (2004) examined the link between technical efficiency and the makeup of the labour force and in (2008) focused on the performance of small and medium-sized manufacturing firms in relation to technical inefficiency and its determinants. With other econometric techniques, Fariñas and Ruano (2004) analysed the contribution of continuing firms and turnover to total factor productivity; Huergo and Jamandreu (2004) measured the probability of introducing innovations by manufacturing firms at different stages of their existence. All of them used the EESE data set of Spanish manufacturing firms.

The novelty that our work incorporates is that it estimates the effect of a higher relative labour cost per worker, on firms' value added through a stochastic frontier panel data model. Here we obtain empirical evidence that a higher relative cost improves productivity in Spanish manufacturing firms. We also test the differences in efficiency between the years of estimation, differentiating between the expansionary period 2004-2006 and the recessive period 2007-2009. We maintain that the increment in unemployment suffered after 2007 reduced technical inefficiency and is evidence in favour of the idea that an increase in the cost of job loss stimulates productivity. Our paper also differs from pervious literature in Spain, because we use an improved frontier model and we calculate the real impact of the coefficient of technical inefficiency through the method of Wan (2002).

The paper is organised as follows: Sect. 2 introduces the econometric method of estimation. In Sect. 3 we describe the sample and the data. In Sect. 4 we present the results of the estimated frontier and the inefficiency determinants. Finally in Sect. 5 we summarise the main conclusion.

2. Stochastic frontier and the inefficiency model.-

We use the SFA (Stochastic Frontier Approach) to estimate a production frontier with inefficiency effects. Specifically, we use a panel data version of the Aigner et al. (1977) approach, following Kumbhakar and Lovell (2000), and Wang (2002) specification, in which technical inefficiency is estimated from the stochastic frontier and simultaneously explained by a set of variables representative of the firms' characteristics. This approach avoids the inconsistency problems of the two-stage approach used in previous empirical works when analysing the inefficiency determinants[4].

The model can be expressed as:

$$Y_{it} = f(X_{it};\beta)\exp(v_{it} - u_i) \tag{1}$$

[4] In a two-stage procedure, first of all a stochastic frontier production function is estimated and the inefficiency scores are obtained under the assumption of independently and identically distributed inefficiency effects. But in the second step, inefficiency effects are assumed to be a function of some firm-specific variables, which contradicts the assumption of identically distributed inefficiency effects.

Where i indicates firms and t represents the period, X is the set of inputs; β is the set of parameters, v_{it} is a two-sided term representing the random error, assumed to be *iid* $N(0,\sigma_v^2)$; u_i is a non-negative random variable representing the inefficiency, which is assumed to be distributed independently and obtained by truncation at zero of $N(\mu_{it},\sigma_u^2)$. The mean of this distribution is assumed to be a function of a set of explanatory variables:

$$\mu_{it} = \delta_0 + \delta' Z_{it} \qquad (2)$$

Given that technical efficiency is the ratio of observed production over the maximum technical output obtainable for a firm (when there is no inefficiency), the efficiency index (TE) of firm i in year t could be written as[5]:

$$TE = \frac{f(X_{it};\beta)\exp(v_{it}-u_i)}{f(X_{it};\beta)\exp(v_{it})} = \exp(-u_i) \qquad (3)$$

The efficiency scores obtained from expression (3) takes value one when the firm is efficient, and less than one otherwise.

The function coefficients (*β*) and the inefficiency model parameters (*δ*) were estimated using a panel data technique to control for unobserved heterogeneity.

The estimates of the inefficiency effects model only indicate the direction of the effects over inefficiency levels. We calculated the marginal effects to show how a change in an exogenous variable affects inefficiency. Following Wang (2002), we obtained the

[5] Individual efficiency scores u_i, which are unobservable, can be predicted by the mean or the mode of the conditional distribution of u_i given the value of (v_i-u_i) using the technique suggested by Jondrow et al (1982).

marginal effects by taking the derivatives of the unconditional mean of the efficiency predictor with respect to each of the inefficiency effects variables (Z_M)[6]:

$$\frac{\partial E(u_i)}{\partial z_M} = \delta_M \left[1 - \Lambda \left[\frac{\phi(\Lambda)}{\Phi(\Lambda)} \right] - \left[\frac{\phi(\Lambda)}{\Phi(\Lambda)} \right]^2 \right] \tag{4}$$

Where δ_M are the coefficients of the inefficiency model, $\Phi(\cdot)$ and $\phi(\cdot)$ are the probability and cumulative density functions of a standard normal distribution respectively, and Λ is:

$$\Lambda = \frac{\mu_*}{\sigma_*} = \frac{\dfrac{\sigma_v^2 \mu_i - \sigma_u^2 (y_{it} - x_{it}\beta)}{\sigma_v^2 + \sigma_u^2}}{\dfrac{\sigma_v \sigma_u}{\sqrt{\sigma_v^2 + \sigma_u^2}}} \tag{5}$$

3. Data and variables.-

The Data source is published in the Spanish Industrial Survey on Business Strategies *(Encuesta sobre Estrategias Empresariales, ESEE).* The data is collected by the *Fundacion SEPI* and sponsored by the Spanish Ministry of Industry. This is supplied as a panel of firms' representative of twenty industrial sectors. A distinctive of the data is that companies contributing in the survey were chosen according to a careful selection structure. The sample of firms includes almost all Spanish manufacturing firms with more than two hundred employees. Firms employing between ten and two hundred employees were chosen according to a stratified random sample representative of the population of small firms. Given the procedure used to select firms participating in the survey, both samples of small and large

[6] Wang (2002) points out that the marginal effects on the conditional mean of u_i are almost intractable and shows that it is equivalent to use the mean of u_i to calculate them.

firms can be considered as samples that allow us to estimate the distribution of any of the characteristics of the population of Spanish manufacturing firms with information available from our data set. Each year a number of additional firms were selected according to a random sampling procedure among the whole population of firms. This selection is conducted using the same proportion as in the original sample (see Fariñas and Jaumandreu (2004) for technical details of the sample)

From the original sample, a number of firms have been eliminated, most of them due to a lack of relevant data. Others were eliminated because they reported a value-added annual growth rate per worker in excess of 500% (in absolute value), and some were rejected because they have fewer than ten workers and, in both cases, they would distort the analysis. Also, we do not include firms after a merger or division process in our sample data. Our sample includes 2,247 firms from the ESEE Survey and refers to an unbalanced panel where we have eliminated those firms for which we do not have two consecutive years of data. Our period of analysis runs from 2004 to 2009. Summary statistics of the data are presented in Table 1.

We estimate a stochastic translog production function adding a term of inefficiency, whose mean is the function of a set of inefficiency determinants.[7]

$$\ln Y_{it} = \beta_0 + \sum_{j=1}^{J} \beta_j \ln X_{ijt} + \frac{1}{2} \sum_{j=1}^{J} \sum_{k=1}^{K} \beta_{jk} \ln X_{ijt} \ln X_{ikt} + \sum_{m=1}^{M} \varphi_m S_{im} + v_{it} - u_i \qquad (5)$$

$$\mu_{(u)_i} = \mu_{(u)} \exp(\delta' Z)$$

The variables used for estimation of the production frontier are the value-added, such as the output variable, and the number of employees in the firm, capital stock and trend,

[7] We imposed the usual symmetry conditions to the translog function

as input variables (X_{it}), the industrial sector dummies (S_i). In Appendix we present a more precise definition of the variables used for estimation and the definition of the inefficiency determinants considered.

4. Analysis of the results.-

From the frontier approach, we obtain a measure of a firm's technical inefficiency compared with the best observations of the sample. The value of the estimates allows us to explain the differences in the inefficiency effects among firms. As technological and market conditions can vary over sectors, we have included sector dummy variables in the production function in order to be able to control them.

The maximum-likelihood estimates of the production frontier parameters, defined in equation (4), given the specification for the inefficiency effects, defined in equation (5), are presented in Table 2. We use the translog specification for the production function and we obtain the expected signs of the inputs estimates.

In this section we present three estimates of the stochastic frontier of production with three alternative inefficiency models. These three estimates all include size variables and while the first two include relative labor costs (RW) the third estimate uses instead the labor costs per unit of production. In the first two cases we have analyzed the effect of relative salaries on inefficiency, while in the third case we have measured effectiveness in terms of production, in which importance is given not only to the retributions received by the workers, but also to the processes of production employed by firms and their organization with regard to their production processes.

In the first case the effect of the economic cycle is measured throughout the years in the sample, and takes as a point of reference the year 2008, which is the year in which unemployment began to rise, moving from 8,3 % in 2007 to 11 % in 2008; in the second and third cases we have constructed a fictional variable to account for take into account the impact of 2008 and 2009.

The results obtained in Table 2 demonstrate that higher relative labour costs reduce the level of inefficiency in firms. This is made apparent by the coefficients in this variable, as in both estimates they are negative and significant. These greater relative costs per worker act as a proxy for the quality of labour. Therefore those firms that are willing to pay more within the same sector reduce the problems caused by an adverse selection of the workforce generated by a poor remuneration policy, avoid the problems occasioned by a continually changing workforce and motivate their staff to make more effort. When we calculate the marginal effects of this variable in Table 3, we find that the impact results in an 8 % reduction of inefficiency in estimate (1) and close to a 7% reduction in estimate (2). In the same sector of industry firms that seek to attract the highest qualified workers in the market place and obtain a higher rate of productivity per worker by means of a policy of paying high salaries and providing good working conditions coexist with firms that use a policy of low salaries to increase their rates of productivity per worker. The use of one policy or another will depend to a great extent on the characteristics of the company.

The coefficient of unit labor costs (ULC) is positive and significant, which indicates, as it should, that higher labor costs per unit of product widen the difference with the frontier of efficient production. The marginal value of the coefficient is 1.4, which shows that its impact is far greater than any other factor included in the inefficiency model. This is without doubt the key point. What is important here are not the labor costs in themselves but what the firm is able to achieve with these costs in terms of production. Therefore, the objective should be not simply to reduce labor costs but to change the model of production by incorporating more efficient uses of technology and by training the workforce.

The size of firms is another important factor to be considered when analyzing the efficiency of firms. In Spain most firms are small or medium sized businesses. In our sample firms that had more than 500 employees made up only 9.45 % of the total. The coefficients, of the three sizes of firm analyzed, where positive and significant with respect to large firms. This result suggests that the smaller a business is, the further it is likely to be from the frontier formed by the most efficient firms in the sample. In Table 3 the marginal effect is greater the smaller the size of the firm in question. Therefore we may conclude that if Spanish businesses increase their average size they will reduce their distance from the stochastic frontier. This result may be partially explained by the fact that large businesses invest much more in research and development than medium and small size businesses. Firms with more than 500 workers are those that receive the highest percentage for innovation in the process of production (54.60%) and in the product (43.01%), (Díaz and Sánchez, 2012).

5. Concluding remarks.-

In the context of globalization the current policy of indiscriminate salary reduction that is being carried out in Spain is affecting productivity and will continue to do so in the long term. In this paper we have obtained evidence of the impact of relative labor costs on the efficiency of businesses, finding that those firms which pay higher than average salaries in their sector reduce inefficiency. What is relevant here are not the labor costs of the businesses themselves but rather what firms may obtain by paying these costs. What is pertinent are the costs per unit of production, which are determined by labor costs on the one hand and on the other by the technology employed, the organizational structure of firms and the ability of managers to organize efficiently the factors involved in production.

A policy such as the one pursued in Spain that is based on the systematic worsening of labor conditions without firms making any changes in their model of production in the middle or long term will result in qualified workers leaving the country, and that will in turn impact negatively on productivity. The Spanish economy will finance the training of young workers who have no real prospects of employment in Spain, either because there will be no jobs that correspond to their level of training or because the remuneration offered for those jobs available will be excessively low compared to other countries in the European Union and beyond.

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APPENDIX: Description of variables and Results

Variables of Stochastic Frontier estimations:

VA: The value added in real terms. This is a dependent variable.

CAPITAL STOCK (K): Inventory value of fixed assets excluding grounds and buildings.

L: Total employment by firm.

T: This is the time trend.

Sector classification: There are seven dummy variables that take value one when the firm belongs to the corresponding sector of activity; otherwise this value is zero.

SEC1: Meat and manufacturing of meat; food industry and tobacco drinks; textiles, clothing and shoes; leather, shoes and derivatives. SEC2: Wood and derivatives, paper and derivatives.

SEC2: Wood and derivatives, paper and derivatives. Category of Referece.

SEC3: Chemical products; cork and plastic; non-metallic mineral products.

SEC4: Basic metal products; manufactured metal products; industrial equipment.

SEC5: Office machinery and others; electrical materials.

SEC6: Cars and engines; other material transport.

SEC7: Other manufactured products.

Determinants of efficiency:

VU09: Variation of unemployment rate for the period 2007-2009 with respect to 2004, 2005 and 2006.

RW: The ratio of firms labour cost by worker over average labour cost by worker for industrial sector.

Time:

There are six dummy variables that take value one when the firm belongs to the corresponding year; otherwise this value is zero. The category of reference is 2008.

Size:

- SIZE 1: Firms with no more than 100 workers.
- SIZE 2: from 101 up to 200.
- SIZE 3: from 201 up to 500.
- SIZE 4: Firms with a number of workers higher than 500. Category of reference

Table 1: Descriptive statistics

	Min.	Max	Mean	Standard Deviation
VA*	110.29	10689161.42	162610.05	553841.99
K*	10.94	33091212.35	357083.77	1609312.16
L	10.00	14400.00	236.90	724.36
RW	0.008	340.63	1.94	10.20
U	8.3	18	10.87	3.28

(*) Euros

Table 2- Stochastic Frontier Analysis: Translog Production function estimates

Variables		Coefficient (1)	Coefficient (2)	Coefficient (3)
Constant	β_0	5.837* (45.21)	5.628* (46.84)	8.359 (0.000)
T	β_1	0.155* (10.59)	0.160* (10.74)	0.143* (9.767)
L	β_2	1.531* (41.09)	1.395* (40.72)	1.175* (25.13)
K	β_3	0.038* (2.24)	0.000 (0,061)	-0.064* (-3.817)
K^2	β_{11}	0.027* (15.16)	0.032* (19.16)	0.029* (16.69)
L^2	β_{22}	-0.011 (-1.67)	0.018* (3.04)	0.028* (3.770)
T^2	β_{33}	-0.013* (-8.77)	-0.013* (-8.70)	-0.011* (-7.900)
KxL	β_{12}	-0.153*	-0.174*	-0.133*

		(-10.78)	(-13.61)	(-9.205)
LxT	β_{13}	0.020* (6.35)	0.023* (7.07)	0.219* (6.491)
KxT	β_{23}	-0.017* (-8.21)	-0.018* (-8.68)	-0.017* (-8.056)
Meat and manufacturing of meat; food industry….	φ_1	-0.047 (-1.20)	-0.041 (-1.18)	-0.006 (-1.771)
Chemical products; non-metallic mineral products.	φ_2	0.137* (3.39)	0.105* (2.89)	0.155* (4.052)
Basic metal products; industrial equipment.	φ_3	0.192* (4.77)	0.182* (4.98)	0.228* (6.060)
Office machinery and others; electric materials.	φ_4	0.216* (4.44)	0.196* (4.60)	0.250* (5.315)
Cars and engines; other material	φ_5	0.060 (1.38)	0.041 (1.044)	0.102* (2.390)

transport.				
Others manufactured products.	φ_6	0.082** (1.93)	0.054 (1.42)	0.138* (3.478)
Inefficiency Model				
Constant	δ_0	4.355* (23.63)	3.931* (26.08)	7.609 (0.00)
RW	δ_1	-0.369* (-14.51)	-0.393* (-17.70)	------------
ULC	δ'_1	------------	------------	3.08* (17.381)
Year 2004	δ_2	0.376* (4.37)	------------	------------
Year 2005	δ_3	0.294* (3.31)	------------	------------
Year 2006	δ_4	0.168* (2.03)	-----------	------------
Year 2007	δ_5	0.087 (1.03)	------------	------------
Year 2009	δ_6	-0.003	------------	------------

		(-0.031)		
VU09	δ_7	------------	-0.054* (-4.931)	-0.041* (-3.633)
Size 1	δ_8	0.972* (6.65)	0.399* (2.92)	1.058* (7.492)
Size 2	δ_9	0.574* (4.08)	0.024 (0.189)	0.777* (5.851)
Size 3	δ_{10}	0.200 (1.61)	-0.135 (-1.147)	0.538* (4.740)
Lambda		1.111* (58.45)	1.034* (60.56)	1.056* (61.135)
Sigma (u)		0.382* (67.64)	0.359* (67.71)	0.361* (69.925)

(*) Significant at 1%; (**) Significant at 10%,.T-Student between brackets.

Table 3: Marginal effects of inefficiency variables

	Model (1)	Model (2)	Model (3)
RW	-0.08092167	-0.06685099	----------
ULC	----------	----------	1.39234951
A2004	0.14000806	----------	----------
A2005	0.10956904	----------	----------
A2006	0.06237158	----------	----------
A2007	0.0320365	---------	----------
A2009	-0.00110285	-----------	----------
VU09	---------------	-0.01854108	-0.01455968
Size1	0.44890939	0.16434714	0.45742946
Size2	0.21589421	0.00888606	0.29055445
Size3	0.07416443	-0.04847444	0.20074521