Working Paper 98-66
Business Economics Series 11
October 1998

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THE EFFECT OF INNOVATION ACTIVITY ON INNOVATING QUASI-RENTS: AN EMPIRICAL APPLICATION (1)

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Abstract

This paper investigates whether innovations generate quasi-rents and whether the size of those quasi-rents are affected by market conditions. Using a panel data of Spanish manufacturing firms during the period 1990-93 we answer affirmatevely to both questions. Product, process and both innovations generate quasi rents and such quasi-rents appears to be higher for process innovations. The size of innovation quasi-rents seems to be affected positively by demand growth, by product standarisation, and by low product market concentration. The three empirical results are in agreement with the theoretical predictions such as the Schmoockler´s theory of demand-pool innovation, the price-elasticity of demand effects of Kamien and Schwartz and the replacement effect of Arrow. Process innovations are more affected by market conditions than the rest of innovations, at the tine of generating quasi-rents.

Keywords: Innovations, quasi-rents, market competition

(1) We are very grateful to the Spanish Ministry of Industry and Energy for providing the data. We would thank to J.M. Labeaga for the econometric guide. We would also aknowledge to J. López-Sintás for the suggestions made to a preliminary version of this paper. All remaining errors are our own.

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1. Introduction

In this paper we investigate whether innovation activities generate economic quasi-rents and if the magnitude of such quasi-rents is affected or not by market structure conditions and firm's characteristics. The data is provided by the ESEE survey on Spanish manufacturing firms and covers the period 1990-93. The methodology used in the paper measures the rents of innovation taking into account that part of such rents are captured by workers with higher wages, and therefore accounting profits do not properly estimate economic rents.

The interests on the determinants of innovation activity by business firms has fuelled an active field of research. Kamien and Schwartz (1982), Cohen and Levin (1989), and Cohen (1995) are excellent surveys in this topic on different moments of time, but all of them traizing the roots of the research to the fundamental insights of Schumpeter (1975). Our paper draws from this literature to formulate the hypothesis to be tested, but incorporates some distinct features which are explained bellow.

Firms will undertake innovation activities if the expected revenues of such activities compensate the certain costs for the resources dedicated to them. Therefore if we are able to isolate and measure the net benefits of innovations activities and relate them to characteristics of the firm and of the market in which the firm operates, then we will know better what determines the incentives to innovate. In fact, most of the previous literature has focused on the factors that determine the resources that a particular firm dedicates to R&D activities.[1] Presumably, if one firm dedicates more resources to R&D, it is because it expects higher profits from the new processes or products that will come out of them, but we believe that it is of interest to know if, in fact, R&D activities increase profitability; if the increase in profitability

[1]See Scherer (1980), Kamien and Schwartz (1982), Levin et al. (1985) or Baldwin and Scott (1987) for surveys of the two main factors, firm size and market structure, which condition the R&D.

varies according to the type of innovation (product or process); and if the size of innovation rents depends upon variables such as the growth or the concentration of the market. These are the main concerns of the paper.

One important methodological issue in this line of research is how to approximate innovation activity. Most often, input measures such as R&D effort (expenditures in R&D relative to value added and number of workers in R&D activities relative to total number of workers) are selected. However, R&D inputs take time before they generate intermediate outputs such as new products, patents and process improvements. Moreover, since they are often treated as current expenditures by the firms then, in the short run, a negative association between R&D effort and accounting profits may be detected.[2]

In this paper innovation activity is measured by a dummy variable that assigns the value of 1 to a firm that in a given year has introduced a product innovation, a process innovation or both, a product and process innovation. The measure has limitations because it is not possible to calibrate the importance of the innovation, but at least all the innovations recognised by the firms are properly registered. The paper also considers the fact that accounting profits will not be a proper measure of innovation rents if part of such rents goes to the workers in the form of higher wages.[3] Previous research by the author has shown that among the firms of the sample there is evidence that innovating firms pay higher wages, ceteris paribus. Therefore, the measurement of the size of the rents generated by the innovation activity will control for this evidence.

The econometric estimation of the empirical model uses panel data techniques. Given the dynamic nature of the model, we apply a new instrumental variables method to achieve consistency in the estimation of the parameters and improve efficiency (Arellano and Bover

[2]As Kamien and Schwartz (1982) pointed out, in that case the R&D is measuring the cost rather than an investment so it would be reasonable to find an inverse relationship.
[3]See Martínez-Ros (1995).

(1995), Blundell and Bond (1995)). The estimation procedure also takes into account the endogeneity problem generated by the simultaneous determination of profits and some explanatory variables such as market share.

Our results show that innovation generates rents and therefore firms have economic incentives to pursue innovation activities. We also find that process innovations generate more rents than product innovations and that the control for the fact that part of the rents are captured by the employees has significant effects in the estimation of the size of such rents. Finally, the empirical results show that innovation rents are inversely related to the product market concentration, i.e., they are lower in more concentrated markets than in less concentrated ones. If less concentrated markets are also more competitive, then innovation rents are higher in more competitive markets, a result consistent with the predictions of Arrow (1962) who postulates that firms in more competitive markets are able to obtain more rents from innovations because competition implies lower profits before the innovation is introduced. Monopolists, on the other hand, have higher profits to begin with, so innovation has a lower incremental effect on them (replacement effect).

The plan of the paper is the following. In Section 2 the main hypothesis are presented, toguether with a basic theoretical formalization. Section 3 contents the empirical model and a description of the variables and their measurement. Section 4 describes the data base. The discussion of the empirical results is presented in Section 5; overall conclusions and extensions close the paper.

2. Innovating rents, firm's characteristics, and market conditions

The decision to innovate is determined by the relation between the benefits and cost associated with such decision. In this section we present an overview of the literature on the determinants of the innovation rents (differences between benefits and costs), in particular the relationship between the rents and the type of innovation (product and process), and the relationship between innovation rents and product market (demand growth, product differentiation and market competition), and labour market conditions.

Innovation is an heterogeneous activity. Lunn (1986) and Kraft (1990), for example, point out the differences in the innovative processes and activities of product and process innovations. In general, process innovations are aimed at introducing technological advances which reduce production costs and, eventually, will help to gain market share from the competitors. Product innovations, on the other hand, expand the production opportunities set and in some cases allow for gains in efficiency due to scope economies. If innovation implies also more product differentiation, then the innovating firms may lower the price-elasticity of its demand function and, consequently, increase its profits margins. Very often product and process innovations will go together and complement on their effect since, for example, a product innovation may demand for a process innovation to respond to a new product design or characteristic.

More difficult is to establish, in general, if there may be differences between the size of the innovation rents attributed to one type of innovation or the other. It may be argued, however, that product innovations will be more easy to imitate since competitors will be immediately aware of them and patent law may not be able to effectively protect the property rights of the innovator. On the other hand, process innovations are not exteriorized by the innovating firm and therefore rival firms may take time before discovering the origin of a particular competitive advantage. All these reasons may suggest that the innovating rents of process innovations will tend to be higher than the rents of product innovations, assuming that both innovations have the same degree of "radicality".

The size of innovation rents will not only be affected by the nature of the innovation but also by the conditions of the market in which the innovating firm operates. Among those conditions the degree of rivalry or market competition is particularly emphasised in the literature.

The "Schumpeterian" view of innovation argues that monopoly power will foster innovation activity because it is a way of assuming that innovation rents will be substantial and that they will last over time as imitation is limited by entry barriers into the market. A firm with market power and a monopolistic position will be subject to an "efficiency effect" in the sense that innovation will be perceived as the only way to protect its privileged position in the market. A potential entrant, on the other hand, will anticipate a lower compensation for its innovation activities since, after entry, a competitive process with the incumbent monopolist will take place.[4]

There exists, however, an opposite view of the relationship between market competition and innovation rents build around the so called "replacement effect", Arrow (1962). If we start with a competitive market where price equals cost and profits are zero, then if innovation is sufficiently important to give market power to the innovating firm, the new equilibrium price will be higher than the innovator's cost and profits will increase substantially. On the other hand, if the market is non competitive, prices are above costs and firms earn positive profits, an innovation will increase profits but in a lower amount since current firms are already making positive profits. In this case, a monopolist which innovates will end up replacing itself, while when the market is competitive innovation may change the market structure towards a monopoly with substantial increase in profits. All this implies that innovations should produce higher rents in firms operating in more competitive markets since in such markets initial profits are expected to be lower.

The relationship between market competition and innovation rents is, therefore, an empirical question. To guide the empirical research some auxiliary hypothesis have been

[4]See Gilbert and Newbery (1982).

formulated. For example, Kamien and Schwartz (1970) show that, under the replacement effect assumption, innovation rents will increase with the absolute value of the price-elasticity of demand, i.e., they will be higher for firms facing more elastic demand functions. One of the reason a firm faces a more elastic demand curve is because there are more substitutes in the market, that is, the market itself is more competitive.

The analysis of Kamien and Schwartz is based upon the assumption of a process innovation that lowers production costs. If the cost reduction is translated into lower prices, then the size of the market served will expand more as the demand function is also more price-elastic. This will in turn determine a positive association between innovation rents and price-elasticity of demand. But when the innovation is in product but not in process, then Spence (1975) shows that improvements in product quality will produce higher innovation rents in markets with more inelastic demands, since they will allow for higher margins. Therefore, the relationship between innovation rents and price-elasticity of demand may be sensitive to the type of innovation being considered.

One more market characteristic that we want to consider is the demand growth. Schmookler (1966) argues in favour of the growth in market demand as the primary force behind technological change. Walsh (1984) elaborates around this idea and points towards the fact that innovation activity requires high investment cost which do not depend upon the demand of the product once the innovation is made. Given the indivisibility of the innovation costs and investments, innovating rents will depend largely on the size and growth of the market for the final products. This will be true for both, product and process innovations.

So far, our attention has been focused on the generation of innovating rents, but for methodological reasons it is important to consider also their distribution. The innovation process will contribute to improvements in products and processes which in turn will increase the value added by conventional inputs such as labour and physical capital. Therefore, innovation should contribute to improvements in total factor productivity. Productivity gains will be, in turn, distributed in the form of higher profits or/and higher wages. When labour markets are competitive, then the productivity gains of innovation will show up in terms of higher profits and consequently the measurement and evaluation of innovation rents can be made either from total factor productivity gains or from increases in profitability. But when workers have bargaining power and capture part of the productivity gains in terms of higher wages, then innovation rents are no longer equal to increments in profitability. As we shall show later on in the empirical section, to account for the issue of appropriability will be very important in order to properly evaluate the rents of innovations from differences in profitability.

2.1. A simple formalisation

The exposition above may be formalised in a simple model which will be helpful in the specification of the empirical equations.

Define the quasi-rents of the firm i in a period t as

$$QR_{it} = p_{it}Q_{it} - w_{it}^{c}L_{it} - r_{it}^{c}K_{it} \qquad [1]$$

where p_{it} is the price, Q_{it} is the output, w^{c}_{it} is the competitive salary, L_{it} is the number of employees, r^{c}_{it} is the market cost of capital and K_{it} is the physical capital. QR_{it} includes the economic profits plus the costs of the innovation activities which are considered sunk costs. The assumption that the costs of innovation are sunk allows us to talk about quasi-rents instead of rents of innovation.

The quasi-rents per unit of monetary output, $QR_{it}/p_{it}Q_{it}$ are assumed to be a function of the stock of knowledge capital, G_{it}, and of market conditions, M_{it}, i.e.,

$$\Pi_{it}(G_{it}, M_{it}) = \frac{QR_{it}}{p_{it}Q_{it}} \qquad [2]$$

For each firm and time period only accounting profits are observed. Therefore it is important to link $\Pi(G_{it}, M_{it})$ with such profits. Define gross profit margin as,

$$m_{it} = \frac{p_{it}Q_{it} - w_{it}L_{it}}{p_{it}Q_{it}} \qquad [3]$$

where w_{it} are salaries actually paid. It can be easily shown that m_{it} and Π_{it} are related by,

$$m_{it} = \Pi_{it}(G_{it}, M_{it}) + \frac{r_{it}^{c}K_{it}}{p_{it}Q_{it}} - \frac{(w_{it} - w_{it}^{c})L_{it}}{p_{it}Q_{it}} \qquad [4]$$

In other words, gross profit margin from accounting profits will be equal to quasi-rents plus the costs of physical capital minus the differences between labour costs at actual and at competitive salaries, all of them normalised by the monetary value of the firm's output.

The stock of capital knowledge, G_{it}, is the result of a continuos innovation process. The underlying assumption is that G is generated by a permanent inventory process of the form,

$$G_{it} = I_{it} + (1-\delta)G_{it-1} \qquad [5]$$

where I_{it} is the number of innovations incorporated into the stock in period t and δ is the rate of depreciation. [5] The (expected) number of innovations generated by firm i in period t will be the result of a search process over time, $E(I_{it}) = \sum_{m=1}^{M} \alpha_m S_{it-m}$, where α_m is a parameter of the effectiveness of the research process and S_{it-m} is the intensity of research in a given period of time. [6]

[5] Alternatively, we could assume that the knowledge stock is constructed using the R&D expenditure as Griliches and Mairesse (1984) proposed.

[6] Reinganum (1989) presents a good survey of the dynamic models of technological activities. Blundell et al (1995) provide an empirical test of the relationship between innovation inputs and outputs.

Product market conditions, M_{it} will affect both, economic profits and the quasi-rents of innovation. Our underlying assumption is that firms compete in an oligopolistic market with product differentiation. Efficiency in production across firms will determine part of their competitive advantages, while market concentration and demand growth may affect the opportunities for collusive behaviour. On the other hand, product market conditions are expected to affect the size of the innovation quasi-rents. All this may be summarised in the following assumptions,

$$\frac{\partial m_{it}}{\partial M_{it}} = \frac{\partial \Pi_{it}(G_{it}, M_{it})}{\partial M_{it}} \neq 0$$

$$\frac{\partial^2 m_{it}}{\partial M_{it} \partial G_{it}} = \frac{\partial^2 \Pi_{it}(G_{it}, M_{it})}{\partial M_{it} \partial G_{it}} \neq 0 \qquad [6]$$

where the particular sign of the cross derivative is determined by the theoretical predictions outlined above. For example, from Schmoockler's predictions we expect that the cross derivative between innovations, quasi-rents and demand growth will be positive.

The competitive cost of capital, r^c_{it} is, in general, difficult to observe and this will have to be taken into consideration in the empirical analysis. Finally, the difference between actual and competitive salaries, $(w_{it}-w^c_{it})$, will be considered in this paper as a measure of the innovations rents and quasi-rents captured by the workers in terms of higher salaries. The particular measure used to estimate the magnitude of the appropriation will be discussed in the empirical section.

3. The empirical model and variables measurement

Following the theoretical analysis of the previous section, the model to be estimated is summarised as follows

$$m_{it} = \beta_0 m_{it-1} + \beta_1 G_{it} + \beta_2 M_{it} + \beta_3 G_{it} * N_{it} + \beta_4 KSA_{it} + \beta_5 X_{it} + \beta_6 Y_{it} + \varepsilon_{it} \quad [7]$$

where m_{it} is the gross profit margin, m_{it-1} is the lagged gross profit margin, G_{it} is the set of innovation variables, M_{it} is the set of variables proxies of market and efficiency conditions, $G_{it}*N_{it}$ is the interaction between innovation and a subset N_{it} of the market conditions variables, KSA_{it} is the ratio of physical capital to sales, X_{it} is the set of variables about the innovation quasi-rents appropriated by the workers, Y_{it} is a set of other control variables and ε_{it} is the error term.

The dependent variable, m_{it}, is measured as the percentage of gross margin over total value of production for firm i in period t; gross margin is equal to the value of production minus costs of inputs from other firms and minus labour costs; the value of production is equal to sales plus changes in inventories.[7] The regression includes the lagged value of the gross profit margin among the explanatory variables, in order to capture the time-varying effects which are further away from the equilibrium solution[8]; for example, lagged profit margins could capture the influence of cash-flows attached to profitability on innovation activity, since more or less cash-flows implies more or less funds available to finance innovation activities.

The variables of innovation activity, G_{it}, are measured in terms of three dummy variables, PROD, PROC and BOTH. The variable PROD takes the value of one when the firm i indicates that, in period t, a product innovation has taken place, and takes the value of zero otherwise; the variable PROC and BOTH are defined in a similar way but when a process innovation, PROC, and both a product and a process innovation, BOTH, are reported by the firm.

[7]For a good explanation of the construction of this variable see Fariñas and Huergo (1994) and Huergo (1994) with the same data base, the ESEE.

[8]Geroski et al. (1993) present a similar specification although the dependent variable is the rate of return.

Innovation activity is measured in terms of output flow. This measure is preferred to other variables often used as inputs of the innovation activity, such as R&D expenditures or R&D personnel, because innovation output is not always the result of formal innovation processes.[9] Innovation counts are also preferred to other measures of output, such as number of patents, since there are many innovations which are no patented by the firms.[10] The choice of an output, such as a number flow instead of a stock measure of knowledge, has been imposed by data limitations. To obtain a more accurate measure of the knowledge base it would have been desirable to take into account not only whether the firm reports innovation in product, process or both, but also the actual number of each innovations (ideally their economic value as well). With such information the stock G_{it} could have been computed using equation [5]. Unfortunately such number of innovations is only available in our data base for product innovations.

If innovation activities generate quasi-rents, then a positive value of the vector β, is expected. Moreover, the size of the β_l coefficient for the variable PROD, PROC and BOTH will indicate whether innovation quasi-rents are different or not for each type of innovation.

The model considers two main variables to account for firm heterogeneity in terms of productive efficiency and market competition, market share, SHARE, and industry concentration, CR4. More efficient firms will capture higher market share and therefore ex-post differences in market share may be good proxies of differences in efficiency across firms. Collusion tends to be easier in more concentrated markets and therefore we would expect that firms in more concentrated markets will earn higher profits. However, if differences in

[9]Each measure presents problems: the number of people involved on R&D activities ignores resource flows from research equipment and materials, while the R&D expenditures include purchases that do not confer significant technological advances to the firm, i.e. the long lived equipment.

[10]Townsend et al. (1981), Pavitt et al. (1987) or Robson et al. (1988) and, more recently, Blundell et al. (1995) use the number of innovations developed by the firms. The main problem of this indicator is the difficulty in identifying the significant innovations, which implies the numerous biases derived of the waste heterogeneity in the economic value of innovations. On the other hand, patent counts (Scherer (1965), Bound et al. (1984), Griliches (1990)) cause problems in the comparison within-industry and between-industry because they are heterogeneous in economic value, as well.

efficiency across firms in the market are important, then a more concentrated market will be the result of differences in efficiency and market share across firms, and not evidence of collusion practices. One way to isolate the efficiency or collusion effects of concentration on profits is to incorporate into the regression the product of market share and concentration, SHARE*CR4. With all this in mind, the vector M_{it} will include three variables, SHARE, CR4 and SHACR4.

The variable SHARE is measured as the ratio of sales of firm i in period t over total industry sales (at the two digits level) in the same time period. Concentration, CR4, on the other hand, is measured as the percentages of sales of the four largest firms in the industry over total industry sales, both in each time period t. Under the assumption that differences in concentration across industries respond to efficiency effects, we expect that the coefficient of SHACR4 will be negative. On the other hand, a positive coefficient of the interactive variable could be an indication that concentration facilitates collusion and this is the reason why profits are higher in more concentrated markets. Smirlock (1985) tests similar hypothesis in a study related to banking firms.

The innovation variables, PROD, PROC and BOTH are interacted with proxies of market conditions such as growth, elasticity of demand and competition. Firms in the data base indicate whether their products are sold in a recessive market or not. Using this information, we define the dummy variable RECES which takes the value of one if the firm responds affirmatively to the question about recessive markets and zero otherwise. According to the theory outlined in section two, innovation rents are lower in market with low demand growth and, consequently, we expect that the coefficient of the interactive variables RECPROD (RECES*PROD), RECPROC (RECES*PROC), and RECBOTH (RECES*BOTH) will be negative.

Price-elasticity of demand is not directly observed, but the data base informs us about the characteristics of the products sold by the firms. In particular, firms collaborating with the

ESEE survey indicate whether their products are standarised or not. Accordingly, the dummy variable EP is defined which takes the value of one when the firm's products are standarised and zero otherwise. The underlying assumption is that standarised products face a more elastic demand and, according to the theory, the interaction variable EPPROC should have a positive coefficient in the regression (higher innovation rents for process innovations). On the other hand, if product innovations imply improvements in product quality, then the innovation could contribute to differentiate the product and increase profit margins. But it is also true that profit margins of standarised profits will tend to be lower to begin with and therefore, in this case, quality improvements tend to imply lower incremental profits. All this implies that the coefficients of EPPROD and EPBOTH have an ambiguous sign.

The third market characteristics that may affect the size of the innovation rents is the intensity of product market competition. Market competition is approximated by market concentration, in an inverse way. With this is mind, the variables PRODCR4, PROCCR4, and BOTHCR4 are constructed. Their coefficients will indicate whether there is an effect of market concentration on the size of innovations rents. A positive value of such coefficient would be consistent with the "efficiency effect", in the sense that firms in more concentrated markets tend to capture more rents because there is less imitation. On the other hand, a negative coefficient would be consistent with the "replacement effect".

The variable $\underline{KSA}_{it}$ is equal to the ratio between the monetary value of physical capital (total assets at replacement costs) and the monetary value of production of the firm i in period t.[11] We expect a coefficient β_4 positive, according to the theoretical model.

In Martínez-Ros (1995) a direct measure of the wage differential (w_{it}-w^c_{it}) attributed to the capture of innovation rents by the workers in terms of higher wages, is provided. To obtain such indicator, we first regress the firm average wage on innovation variables distinguishing

[11]See Martín and Suárez (1996).

between product, process innovations and both and other human capital controls. Then, we take the three β estimates corresponding to the innovation variables and multiply them by the PROD, PROD and BOTH dummy variables. In this procedure we are assuming that the only factor that contributes to increase wages is the introduction of some technological advance. Notice, however, that in the theoretical model the wage differential is multiplied by the inverse of labour productivity. The new variables included in the X_{it} vector of the econometric model, BPRODLSA, BPROCLSA, BBOTHLSA are constructed as the product of the estimated wage differential times the inverse of labour productivity. According to the theoretical model the coefficients in the vector β_5 are expected to be negative

Two additional control variables are included in the regression; vector Y_{it}: export activity of the firm and technological activity in the industry. Export activity is measured by a dummy variable which takes the value of one if the firm exports and zero otherwise, DEXP; with this variable we control for differences in margins attributed to differences in the scope of markets served by the firm. On the other hand, firms may profit from spillovers coming from the research activities performed by other firms in the same industry. To account for this, the variable KPROD is defined and introduced into the equation. The variable counts the number of product innovations generated by all firms in a given two-digit industry and computes a stock of knowledge using equation [5].[12]

The error term ε_{it} includes unobservable firm specific effects, μ_i, and random-time varying effects, v_{it}, i.e. $\varepsilon_{it} = \mu_i + v_{it}$. The firm specific effects may be justified by the fact that the managerial choice of the strategy for a particular firm, will be related with the sources of profits in the past. Since the error term ε_{it} will be correlated with the lagged dependent variable because of the fixed time invariant effect, μ_i, the econometric estimation will have to account

[12]The depreciation rate is the 30%. The novelty of this indicator is the use of an output measure to capture the spillovers effect. Geroski et al. (1993) have yet tried for the UK while Levin and Reiss (1988) have done for the US but using R&D expenditures. Results are very different according to the variable used, while for the UK the effect is small and imprecise, for the US the effects are important and significant.

for this correlation in order to avoid estimation biases. One way to solve this problem is to transform the variables in first differences and use differences in t-2 values of the dependent variables as valid instruments of the variable in t-1; Anderson and Hsiao (1982), Arellano and Bond (1991).

A more recently developed method of solution, Arellano and Bover (1995), instruments the lagged variable, m_{it}, with Δm_{it-1}; the efficiency of estimation is now increased, and as long as there is no serial correlation in the error term, the estimated coefficients are consistent estimators. The estimation procedure also takes into account that market share will be endogenous and jointly determined with profit margins; for this reason market share is instrumented by its lagged value.[13]

4. Descriptive statistics of the data

The data used to estimate the empirical model and to test the hypothesis outlined above, come from the survey ESEE and covers the time period 1990-1993. A balanced panel of the data consisting of 973 firms with four time periods is available. Table 1 presents descriptive statistics of the dependent and explanatory variables for the whole sample and two subsamples, each one selected taking into account the innovation activity of each firms in along time. The data in column headed *Output in R&D* is selected using an indicator of innovation (whether product or process innovation is carried out). Column under the heading *Input of R&D* includes all observations with positive R&D expenditures. Obviously, the sample size is different because not all firms investing in R&D have success in terms of some innovation output. In fact, we could observe that only 65 percent of the firms that invest get some result. It confirms the idea that not all investment in R&D is traduced directly in technological advances.

[13]See Geroski et al. (1993).

Since we are interested in this paper in the effects of innovation (among other varaibles) on margins, we are going to analyse in more detail these statistics. Profits of innovating firms are very similar to those of non-innovating ones. Moreover, there are not differences in profits amongst firms grouped according to innovation inputs or outputs. These crude descriptive statistics seem to suggest that there will not be effects of innovating variables (whether input or output) on margins when using unconditional measures. However, when we evaluate profit profiles conditional on other variables, we could observe different results. They are reported in Figure 1. We compute margins conditional on firm size using the whole sample and the two quoted subsamples, in an attempt to separate firms investing in R&D from those getting succes of its investment (although we must keep in mind that there are firms common to both samples). We must note that profit figures are different because they reflect average values calculated using different number of firms in each sample.

Table 1. Descriptive Statistics of the Variables

Variable	Definition	All firms Mean (Std.Dev.)	Output of R&D[2]. Mean (Std.Dev.)	Input of R&D[3] Mean (Std.Dev.)
Margin (M)	Added value less cost production divided by total production	0.108 (0.143)	0.107 (0.135)	0.104 (0.142)
Market Share (SHARE)	Total firm sales divided by two-digit industry total sales of the sample	0.035 (0.125)	0.053 (0.164)	0.073 (0.184
Concentration (CR4)	Four-firm two-digit industry concentration ratio by sales	0.215 (0.204)	0.233 (0.211)	0.233 (0.202)
Export (DEXP)	Dummy equal to 1 if firm exports	0.544 (0.498)	0.707 (0.455)	0.844 (0.363)
Capital (KSA)	Capital divided by total firm sales	6.177 (27.48)	2.734 (11.07)	1.328 (7.432)
Knowledge capital				
PROD	Dummy equals to 1 if firm carries out only product innovation	0.096 (0.294)	0.236 (0.425)	0.138 (0.345)
PROC	Dummy equals to 1 if firm carries out only process innovation	0.151 (0.358)	0.372 (0.484)	0.186 (0.390)
BOTH	Dummy equals to 1 if firm carries out both product and process innovation	0.159 (0.366)	0.392 (0.488)	0.325 (0.469)
Knowledge produced (KPROD)[1]	Total number of innovations produced in two digit industries	3.809 (5.543)	4.073 (5.429)	3.472 (4.387)
Technological effort (EFFORT)	R&D expenditure over total firm sales	0.007 (0.022)	0.012 (0.026)	0.020 (0.033)
Number of observations		3892	1580	1442

1. Variable constructed using equation [5]
2. Innovating firms have been selected if they have developed some innovation along the period independing of the innovation type.
3. Innovating firms have been selected using the technological effort as indicator.

In other to draw average profits and size of the firm, we define six size intervals. 1: firms with less than 20 workers. 2: between 21 and 50. 3: between 51 and 100. 4: between 101 and 200. 5: between 201 and 500. 6: more than 500 workers.

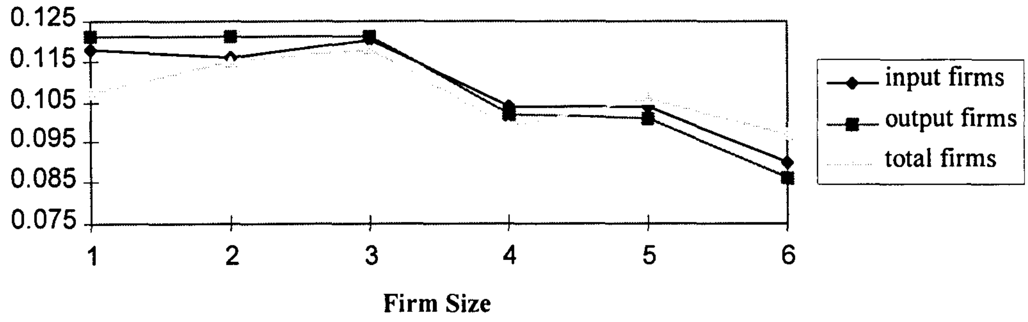

Figure 1. Average Profit Margins according to firm size.

Although the profiles are rather similar, the average margins by firm size are different in the three samples. Those firms with less than 100 workers present higher profits on average than large firms independent of the sample. Figures by innovation type lead to interesting findings. Using the third size interval as a threshold, we observe an inverse tendency when using an input or an output to select the sample. Average profits of small firms are higher when we use the output of innovation while the reverse occurs with large companies. This evidence confirms the specificity of Spanish firms in terms not only of the effects of size on innovation variables (see Labeaga and Martínez-Ros, 1996) but in terms of the effects of size on other variables. Finally, when computing profits conditional on variables as market share or exports, the results are also very different. This suggests that several of the conditionings in Table 1 (in addition to innovation variables) must help to explain the profits of Spanish manufacturing firms.

5. Model estimation

The estimation of the model is performed in two steps. First, we measure the size of innovation rents and second we investigate their relationship with market characteristics.

According to the first column of Table 2 all the explanatory variables not related with innovation activity have statistically significant coefficients. Besides, all these coefficients are positive, except the one for the interactive variable SHACR4 which is negative. This means that firm's profits are sensible to market and firms characteristics. The coefficient of the lagged dependent variables is 0.229 and highly significative, therefore the short run effects of the explanatory variables on the profit margins are approximately one fifth of their long run effects. Profits margins are positively associated with market share and with market concentration; the negative coefficient of the interactive variable indicates that market share and market concentration are related with profits through the efficiency effect. To be an exporter and to operate in sector with more innovative activity have positive effects on profits. The positive coefficient of KSA indicates that part of the gross profit margins go to pay a competitive cost of capital.

Column two of Table 2 shows the same results after the innovation variables have been included in the regression.[14] The coefficients of the innovation variables are, as expected, positive and highly significative. The coefficients of the rest of the explanatory variables are slightly reduced, but all remain statistically significant except the one for the variable market share. The effect of both types of innovation on quasi-rents are not homogenous. At 14 percent level of significance we reject the null hypothesis $\beta_{prod} = \beta_{proc}$.[15]

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[14]The highly significance of the three technical variables included in the estimation confirms the hypothesis of no homogenous innovation activity pointed out by Kamien and Schwartz (1982), Lunn (1986) or Kraft (1990) among others.
[15] It is a tipical F-test with one degree of freedom in the numerator corresponding to one restriction.

Table 2. Profit Margins and Innovations[1,2]

Variables	(1)	(2)	(3)
$MARGIN_{t-1}$	0.229 (4.18)	0.232 (4.31)	0.227 (4.20)
SHARE	0.336 (1.70)	0.303 (1.55)	0.267 (1.37)
CR4	0.079 (4.99)	0.064 (4.12)	0.064 (4.10)
SHACR4	-1.012 (2.39)	-0.952 (2.30)	-0.902 (2.20)
DEXP	0.030 (3.98)	0.018 (2.30)	0.016 (2.06)
KPROD	0.001 (3.27)	0.001 (2.79)	0.001 (3.16)
KSA*10	0.002 (1.90)	0.002 (2.03)	0.002 (2.25)
PROD		0.026 (2.68)	0.048 (3.01)
PROC		0.039 (4.43)	0.065 (4.19)
BOTH		0.029 (3.24)	0.059 (3.30)
BPRODLSA			-0.081 (1.77)
BPROCLSA			-0.087 (1.67)
BBOTHLSA			-0.045 (1.65)
Wald test[3]	28.17 (3)	24.20 (3)	27.63 (3)
Sample size	3892	3892	3892

Notes.

1. t-statistics robust to heteroskedasticity.
2. All regressions pass the hypothesis of joint significance of regressors using the Wald test.
3. Wald test is different in each specification: in (1) refers to CR4, SHARE and SHACR4; (2) and (3) to innovation variables.

The last column of Table 2 introduces into the estimation the variables which take into account that part of the innovation quasi-rents go to the workers in terms of higher wages. The coefficients of these variables are negative and statistically significative as predicted by the theoretical model. But the most important result is now that the coefficients of the innovation variables are almost twice their value of column two. When we control for the rents that are captured by the workers, then differences in profit margins attributed to differences in innovation output are equivalent to the effect of innovation in total factor productivity. The results show that innovation quasi-rents in terms of total factor productivity, are substantially higher than those associated with differences in profit margins (column two).

The final step in the estimation of the model is to investigate if the size of the innovation quasi-rents are sensible to characteristics to the product market. Table 3 shows the result of estimating the model with the interactive variables $G_{it}*N_{it}$ among the explanatory ones. As expected, innovation quasi-rents are lower for firms selling products in recessive markets than for firms in non-recessive ones (column one of Table 3). This is true specially for process innovation and for both, product and process innovations together, since the coefficient of REPROD is non statistically significant. Therefore product innovation seem to be equally effective in generating quasi-rents in growing and in non growing markets.

Product standardisation only affects the size of innovation quasi-rents, with respect to the rents of non standarised (i.e. differentiated) products, for joint product and process innovations together. The positive coefficient indicates that joint product and process innovations generate more quasi-rents when products are standarised than otherwise. As we indicated above, product standardisation implies, ceteris paribus, higher price-elasticity of demand. Either type of innovation alone does not appear sufficient to affect quasi-rents differently from non standarised products, but when both innovations together take place, then the opportunity to lower price and expand demand (from process innovation) and the opportunity to soften competition improving the product (from product innovation) produce higher innovation quasi-rents in firms with standarised products than in firms with non standarised ones.

Market concentration affects the size of innovation quasi-rents in a negative and statistically significant way, column three of Table 3.[16] This is true specially for process

[16]We were concern about the possibility that concentration were endogenous but, a Hausman test (F = 0.00078) allows us to reject the null hypothesis of endogeneity at any significance level.

innovations and for both, product and process innovations. As more concentrated markets are considered also as markets where competition is less intense, then the empirical evidence is in favour of the replacement effect: innovation quasi-rents are higher in more competitive markets because firms start with lower profits before the innovation takes place.

The last column of Table 3 shows the estimated coefficients of the model when all the variables are included. Now collinearity effects are more severe, but the basic results obtained step by step are maintained.

Table 3. Innovation Rents and Market Conditions[1,2]

Variables	Demand growth	Product standardisation	Market competition	All effects jointly
$MARGIN_{t-1}$	0.244 (4.59)	0.248 (4.65)	0.229 (4.30)	0.247 (4.70)
SHARE	0.277 (1.31)	0.251 (1.22)	0.215 (1.07)	0.229 (1.07)
CR4	0.061 (3.76)	0.060 (3.70)	0.092 (4.93)	0.085 (4.47)
SHACR4	-0.904 (1.90)	-0.877 (1.91)	-0.756 (1.78)	-0.777 (1.65)
DEXP	0.013 (1.71)	0.014 (1.79)	0.011 (1.50)	0.010 (1.31)
KPROD	0.001 (3.08)	0.001 (3.05)	0.001 (2.55)	0.001 (2.59)
KSA*10	0.002 (2.30)	0.002 (2.29)	0.002 (1.83)	0.002 (1.95)
PROD	0.051 (3.54)	0.036 (1.96)	0.066 (3.14)	0.060 (2.57)
PROC	0.074 (4.56)	0.050 (2.60)	0.106 (5.26)	0.099 (4.36)
BOTH	0.079 (4.51)	0.038 (1.68)	0.083 (3.74)	0.074 (2.81)
BPRODLSA	-0.077 (1.69)	-0.082 (1.80)	-0.085 (1.88)	-0.083 (1.81)
BPROCLSA	-0.072 (1.35)	-0.075 (1.43)	-0.104 (1.98)	-0.082 (1.53)
BBOTHLSA	-0.037 (1.37)	-0.051 (1.88)	-0.046 (1.75)	-0.037 (1.40)
RECPROD	-0.014 (0.86)			-0.011 (0.68)
RECPROC	-0.032 (2.11)			-0.028 (1.96)
RECBOTH	-0.060 (4.08)			-0.058 (3.93)
EPPROD		0.011 (0.63)		0.011 (0.65)
EPPROC		0.021 (1.40)		0.016 (1.10)
EPBOTH		0.035 (2.06)		0.031 (1.91)
PRODCR4			-0.070 (1.63)	-0.071 (1.54)
PROCCR4			-0.127 (3.49)	-0.111 (3.11)
BOTHCR4			-0.087 (2.13)	-0.066 (1.56)
Wald test[3]	38.67 (3)	10.91 (3)	35.46 (3)	24.12 (3)
Sample size	3692	3692	3892	3692

Notes.
1. t-statistics robust to heteroskedasticity.
2. All regressions pass the hypothesis of joint significance of regressors using the Wald test.
3. We test the significance of the three innovation variables.

6. Conclusions

This paper has addressed two main questions: do innovations generate quasi-rents?; are the size of quasi-rents affected by market conditions? The answer to both questions is yes. Product, process and both innovations generate quasi rents and such quasi-rents appears to be higher for process innovations. The size of innovation quasi-rents seems to be affected positively by demand growth, by product standardisation, and by low product market concentration. The three empirical results are in agreement with the theoretical predictions such as the Schmoockler's theory of demand-pool innovation, the price-elasticity of demand effects of Kamien and Schwartz and the replacement effect of Arrow. Process innovations are more affected by market conditions than the rest of innovations, at the time of generating quasi-rents.

The previous empirical results are obtained from a panel data of Spanish manufacturing firms during the period 1990-93. The econometric estimation has controlled for long-run effects and has corrected for endogeneity problems as well as for the correlation between explanatory variables and the error term. Other important methodological aspects of the paper are that innovation activity is measured in terms of output and that the estimation of the size of innovation quasi-rents has taken into account how such quasi-rents are distributed between higher wages and higher profits. This means that the final estimation of innovation quasi-rents is a measure of the contribution of innovation to total factor productivity. From another perspective, our results remark the biases that may be incurred if innovation quasi-rents are measured only in terms of differences in firm's profitability.

The results of the paper have important implications. First, the fact that innovation generates quasi-rents raises the issue of why some firms innovate and the other do not. We can not answer this question but notice that the costs of innovation are not incorporated into the analysis because they are treated as sunk costs. Therefore for some firms the expected quasi-rents ex-post may not be sufficient to cover the costs ex-ante and decide not to carry out format and costly innovation activities. One interesting extension of the paper would be to investigate whether the conditions that favour higher quasi-rents ex-post are also the conditions that tend to induce higher investment of resources in innovation activity ex-ante.

The evidence that innovation quasi-rents are partially captured by the workers in terms of higher wages may be, in principle, contrary to invest resources in innovation activity since the workers do not pay for such investments. But the higher wages may be a way of incentivating the workers to actively participate in incremental innovations (such as those which are part of Total Quality Management practices). If this was the case, higher wages would be a way of stimulating innovations and, ex-post, innovation activity may be even higher than when workers do not participate of the innovation gains. To analyse the relationship between innovation activity and the share of innovation quasi-rents would be another important extension of the paper.

Our results show that product innovations may be more effective, in terms of generating quasi-rents, than process innovations, for firms which operate in recessive markets. Therefore, the innovation strategy of a particular firm should be designed taking into account market conditions such as demand growth. The same recommendation can be made for firms which produce and sell standarised products; these firms may obtain higher innovation quasi-rents than firms that differentiate their products, if they introduce product and process innovations. So, the marginal returns of innovation appears to be higher in firms with standarised products, probably because firms that have already differentiated their products obtained the higher incremental gains of innovation in the past.

Market concentration lowers innovation quasi-rents, specially for process innovations. If market concentration is an inverse measure of market competition, then innovation quasi-rents, and presumably innovation activity, are positively associated with product market competition. This result is in favour of the thesis postulated by Arrow and contrary to

Schumpeter's hypothesis: Firms in competitive markets obtain a higher price from innovation because their starting level of profits is low. This result has implications for competition policy since dynamic efficiency appears also positively associated with product market competition.

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APPENDIX 1

In this appendix we present more descriptives of the behaviour of the innovating firms. Two tables are reported. The Table A.1.1. describes the average profits according to firm size while Table A.1.2. describes also the average profits but using firm product activity. In both tables we consider the different forms that firms carry out innovation. In particular, we separate whether firms engage or/and hires innovation activity.

Table A.1.1. Average profits by firm size and innovation types period 1990-93[1]

	Non-innovating	Only engage innovations	Only hire innovations	Engage and hire innovations
Group 1. less than 20 workers	10.59 (981)	12.37 (49)	10.88 (22)	11.46 (32)
Group 2. between 20 and 50	11.40 (710)	14.89 (76)	10.02 (24)	9.15 (55)
Group 3. between 50 and 100	11.84 (190)	11.17 (63)	16.79 (25)	8.64 (26)
Group 4. between 100 and 200	9.47 (167)	10.51 (66)	13.97 (15)	9.12 (52)
Group 5. between 200 and 500	11.01 (303)	10.74 (290)	12.91 (42)	9.44 (244)
Group 6. more than 500 workers	12.59 (90)	10.86 (146)	14.39 (11)	7.44 (213)
Total	10.97 (2441)	11.36 (690)	13.02 (139)	8.77 (622)

Notes
1. In brackets are reported the number of observations.

It is interesting to observe that the values of profits are very different depending on the way the innovation activity is carried out.[17] Not all firms that engage innovations hire technological services outside the firm but, the number of firms which produce innovation are

[17] We consider to develop innovation activity if firm hires or engages some technological innovation without distinguishing *a priori* the innovation types (product or process).

larger than those which produce and hire innovation jointly. Attending to the average profits, the conclusions do not follow a similar pattern neither in size nor in innovation contract.

In general, we can affirm that companies which only hire innovations are more profitable although, if we observe along the size intervals, the very small firms present margins down those of firms which engage innovation. It is in this last size group (1 and 2) jointly with group 3 where profits on average are larger than in the rest of intervals. The analysis of the results attending to the figures of the cross-tabulation offers relevant findings. Specifically, the very small firms which engage innovations report the largest mark-ups while the reverse occurs for firms which only hire the technological activity. Surprisingly, firms with less than 20 employees which combine the hire and the engage of innovations have the largest margin compared with the rest of size intervals. However, in any case the margins of this third column are bigger than those of the first column. It seems clear that if we draw the figures of this table we would observe a different curve for each innovation category according to the size.

The second table summarises average profits by industries. We observe that not necessarily the average profits in non-innovating firms are smaller that those in innovating ones. For instance, non innovating firms belonging to the *Electric products* sector reports the largest mark-up. *Chemical and Food and beverages* have larger margins independently of whether firm engage or hire the innovation activity. It is notice to mention the margin of 21 percent that presents the *Food and beverages* industry when only hires innovation. It could indicate that the technological opportunity in this industry is high likely due to the easily diffusion of some new product or process introduced in the market.

Table A.1.2. Average profits by sector and innovation types period 1990-93[1]

	Non-innovating	Only engage innovations	Only hire innovations	Engage and hire innovations
Chemical products	12.80 (599)	13.28 (170)	12.82 (39)	10.71 (216)
Electric products	11.83 (162)	7.65 (110)	6.92 (9)	8.03 (115)
Mechanical	8.77 (202)	10.07 (126)	11.01 (13)	3.48 (127)
Food and Beverages	11.11 (465)	13.36 (115)	21.28 (22)	13.74 (62)
Leather, wooden and paper products	10.12 (1013)	11.43 (169)	11.36 (56)	9.08 (102)
Total	10.97 (2441)	11.36 (690)	13.02 (139)	8.77 (622)

Notes.

1. In brackets are reported the number of observations.