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Innovation and job creation in a dual labor market: Evidence from Spain*

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Abstract

This paper studies the effect of product and process innovations on job creation in the Spanish manufacturing sector over the period 1991-2005. We use a change in the Employment Protection Legislation in 1997 to study the effect of innovations on permanent and temporary workers before and after that change. We find that: (i) product and process innovation created jobs, (ii) before the change in the EPL in 1997 innovations did not affect the number of permanent workers and all the increase in employment was explained by the increase in the number of temporary workers, (iii) after the change in the EPL, innovations increased both the number of temporary and permanent employees, and (iv) while the increase in temporary workers takes place after one year of the innovations, the increase in permanent workers occurs mainly two year after the innovations.

Keywords: Product Innovation, Process Innovation, Employment, Employment Protection Legislation, Temporary Workers.

JEL Classification: J21, J38, L60, O31

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1. Introduction

The fear that technical progress and innovation would destroy jobs has been present in the public debate for a long time. The reason for this debate –in addition to its importance—is the fact that effect of innovation on employment is not straightforward. There are several compensation mechanisms that can counterbalance the initial effect of innovation and render the final effect undetermined (see Vivarelli, 1995, ch. 2 and 3; Petit, 1995; Pianta, 2005; and Piva and Vivarelli, 2005). Innovation can create or destroy employment depending on market structure, institutional setting, and the type of innovation the firm introduces. The introduction of a new or significantly improved product increases employment via an increase in demand. However, if after the innovation the innovator enjoys of market power, it can set prices that maximize its profits but imply a reduction in output. Therefore, the net effect of a product innovation could be a contraction in employment. A new product can also destroy jobs if it is designed to reduce costs. It is also possible that product innovations do not change employment; this would be the case if new products replace old products without changes in demand. The effect of process innovation can also be ambiguous. The development –or the adoption—of process innovations leads to greater efficiency of production, with savings in labor and/or capital, and with a potential for price reductions. The usual outcome is higher productivity and loss of employment. However, if process innovations increase quality or reduce prices, a rise in demand –when elasticity is high— may result in employment creation.

In spite of the fact that the theoretical effect of innovation on employment is ambiguous, several firm-level studies have found that the fear that innovation would destroy jobs has no empirical support. In fact, the evidence shows that firms tend to hire more workers after the innovation occurs. Using a panel of 598 UK firms, Van Reenen (1997) finds evidence in this direction. Blanchflower and Burgess (1998) confirm the positive link between innovation and employment for British firms. These authors also find a positive link for Australian establishments. Entorf and Pohlmeir (1991) and Smolny (1998) studied German firms and found positive effect of product

innovation on employment and no effect of process innovations.[1] Using a panel of 575 Italian manufacturing firms, Piva and Vivarelli (2005) finds evidence about the positive relationship between innovation and employment. Firm-level evidence also suggests that while product innovation creates jobs, process innovation might in fact destroy jobs. To capture this idea, Harrison et al (2008) pose a simple model to study the differential effect of product and process innovation on employment growth. They estimate their model for the manufacturing and service sectors in France, Germany, Spain and the UK. They find that the increase in employment due to product innovations is large enough to compensate the negative effect of process innovations. The results are similar across countries, although there emerge some interesting differences; indeed, they find no evidence for a displacement effect of process innovation in Spanish manufacturing. They suggest that this result can be possible explained by a greater pass-through of productivity improvements in lower prices. This finding is in line with previous evidence for Spain presented by Alonso and Collado (2002) who found that innovative firms tend to create more and destroy less employment than non-innovative firms. Hall et al (2006) and Benavente and Lauterbach (2008) estimate the model in Harrison et al (2008) for Italy and Chile, respectively, and find similar results.

Firm-level studies focus on the direct effect of innovation on employment –i.e. the effect of innovation on the level of employment of the innovating firm. Innovation also has indirect effects –i.e. on non-innovating firms. The indirect effects are intuitive for product innovations; it is not difficult to imagine a scenario in which a product innovation increases the demand of the innovating firm and its employment but reduces the demand of its competitors and their employment level. Process innovation also has indirect effects. The innovating firm can increase its productivity and by reducing price can gain market share, increase its demand for labor and reduce the demand of labor of competitors. Pianta (2005) reviews several industry-level studies addressing these issues. The studies reviewed by him include Meyer Kramer (1992), Pianta et al (1996), Vivarelli et al (1996), Pianta (2000, 2001), Antonucci and Pianta (2002), and Evangelista and Savana (2002, 2003). The empirical evidence presented in these studies shows that the

[1] Although most of the evidence is in favor of positive effect of innovation on firms' employment, there are some studies finding the opposite. For example, using plant-level data for Norway, Klette and Forre (1998) found negative correlation between R&D and employment.

impact on employment is positive in industries characterized by high demand growth and an orientation towards product (or service) innovation, while process innovation leads to job losses. The evidence about overall effect is mixed; it depends on the countries and periods considered. However, some general patterns emerge. The effect is more positive the higher the growth in demand, the importance in the economy of highly innovative industries (both in manufacturing and services), and the orientation toward product innovation. In open economies, countries with an economic structure of this type are likely to receive a disproportionate part of the employment benefits of innovation; countries with stagnant economies and less innovative industries are likely to experience serious job losses due to technological change.

Innovation not only affects the number of employees but also the composition of employment. The effect of innovation on the skills composition has been largely studied (Autor, et al 1998; Caroli and Van Reenen, 2001; Bresnahan, et al. 2002; and Greenan, 2003). The evidence about the effect of innovation on the composition of employment in terms of labor contract is, on the other hand, scarce. Because of the uncertainty about the success of the innovation and the dismissal costs it is sensible to expect that, at least at the beginning, most of the job creation occurs with fixed-term contracts. If the innovation is successful, it is possible to expect that those temporary workers receive an open-ended contract. However, it can also be the case that new products or processes require workers with specific skills and that those workers are not willing to accept fixed-term contracts. In this case, it is possible that innovations create jobs with open-ended contracts even from the beginning.

The type of employment –in terms of labor contract—that it is created or destroyed by innovation is particularly important in Spain. In the early eighties the unemployment rate in Spain was around 20 percent and a change in the Employment Protection Legislation (EPL) in 1984 allowed firms to offer fixed-term contracts to any unemployed worker. As a consequence, the proportion of temporary workers soared up to 35 percent during the nineties. Aiming at reducing the proportion of temporary workers, the EPL was changed in 1994, 1997, and 2001. The high proportion of temporary workers in Spain has been studied from different angles. For example, Dolado et al (2002) provides an analysis of why this rate remained so high after the reforms; Amuedo-Dorantes (2000) and Güell and Petrongolo (2007) study the conversion rate from temporary workers into permanent workers, and Dolado and Stucchi (2008) study the effect

of the high proportion of temporary workers and low conversion rates to permanent workers on firms' productivity.

In this paper, we study the effect of product and process innovations on the total number of workers and on the number of permanent and temporary workers. We use data from Survey on Business Strategies (ESEE). This survey provides us with an unbalanced panel of 2,372 firms that is representative of the Spanish manufacturing sector for the period 1991-2005. This period of time is long enough to study the effect of innovation several years after the innovation take place. Moreover, the change in EPL that occurred during this period allows us to study the effect of innovation on the composition of employment before and after the change in regulation. Another important characteristic of the dataset is that provides us with information on product and process innovation outcomes. Using innovation outcomes instead of innovation inputs, like the expenditures in R&D, is an important advantage because of the high uncertainty of this type of investment and because the relation between R&D investment and innovation depends on the innovation strategy followed by the firm (Veugelers and Cassiman, 1999). Similarly, having disaggregated data for process and product innovation is important because the effect and compensation mechanisms of each type of innovation are different (Harrison et al 2008).

Our results are in line with previous firm-level evidence, both product and process innovation increased employment in the Spanish manufacturing sector. This finding shows that Harrison et al (2008) results are robust even after controlling for the effect of the business cycle, changes in regulation, and any other time varying factor that affect all the firms in the same industry and the effect of any time invariant non-observed firm characteristics. Analyzing the period 1991-2005 we conclude that after the innovation firms hire temporary workers and after evaluating the success of their innovation they hire permanent workers or convert fixed-term contracts into open-ended contracts. However, this conclusion hides an interesting pattern. Before the change in EPL in 1997, firms hired temporary workers and were reluctant to offer open-ended contracts after the innovation. In fact, before 1997, even after two years of the innovation, innovating firms only increased the number of temporary workers. After the EPL change in 1997, innovating firms were willing to offer open-ended contracts. After one year of the innovations they mainly hired temporary workers and after two years of the innovation they hired permanent workers.

The rest of the paper is organized as follows. Section 2 describes the dataset and provides descriptive statistics. Section 3 presents the econometric model and the estimates of the effect innovations on employment. Section 4 presents the results before and after the change in the EPL in 1997. Finally, section 5 concludes.

2. Data and Descriptive Statistics

We use individual firm data from the Survey on Business Strategies (Encuesta sobre Estrategias Empresariales, ESEE) which is an annual survey on a representative sample of Spanish manufacturing firms. The sample period is 1991-2005. In the base year, firms were chosen according to a sampling scheme where weights depend on their size category. All firms with more than 200 employees are surveyed and their participation rate in the survey reached approximately 70 percent of the overall population of firms in this category. Likewise, firms with 10 to 200 employees were surveyed according to a random sampling scheme with a participation rate close to 5 percent. This selection scheme was applied to each industry in the manufacturing sector. Another important feature of the survey is that the initial sample properties have been maintained in all subsequent years. Newly created and exiting firms have been recorded in each year with the same sampling criteria as in the base year. Therefore, due to this entry and exit process, the dataset is an unbalanced panel of firms. We are interested in addressing the effect of innovation on employment one, two, and three years after the innovation takes place. Therefore we restrict the attention to those firms with at least three consecutive observations of the variables of interest. The total number of firms and observations in our dataset is 2,372 and 20,399 –firms have in average eight consecutive observations between 1991 and 2005. There are 505 firms with information for the fifteen years.

Table 1 shows the definition of the main variables in the analysis and Table 2 the descriptive statistics. The first two columns show the mean and standard deviation of the main variables for small and medium sized enterprises (SME). Columns 3 and 4 do the same for large firms. Panels A, B, and C show the descriptive statistics for all the firms in the sample, for firms that do not innovate and firms that at least introduced one product or process innovation between 1991 and 2005.

[Tables 1 and 2 about here]

Large firms are older than SMEs; their average age is 36 years and the average age of a SME is 19 years. Large firms have lower proportion of temporary workers. While SMEs have in average 36 permanent workers and 10 temporary workers (3.6 permanent workers per temporary worker), large firms have in average 633 permanent workers and 94 temporary workers (6.7 permanent workers per temporary worker).

Given that several product innovations require changing the production process and product and process innovations can have different effect on employment, we allow product innovation (*prod*) to include process innovations and define process innovation (*proc*) to capture the effect of a new process producing the same products –i.e. process innovation does not include product innovation.[2] Table 2 shows that the proportion of innovations is higher in large firms; 22 percent of the observations of large firms have a process innovation without a change in the product and 40 percent of them have a product innovation. In SMEs these numbers are 16 and 20 percent, respectively.

Out of the 2,372 firms, 461 never did a product or process innovation and 1,911 innovated at least once. When comparing innovators with non-innovators we observe that innovators are larger, older, and have lower proportion of temporary workers (even within each size category).

3. The effect of innovation on employment

Consider a perfectly competitive and profit maximizing firm that hires workers under either temporary or permanent contracts to produce according the following production function:

$$Y = A\left[(\alpha L_P)^{\rho} + (\beta L_T)^{\rho}\right]^{1/\rho} \qquad (1)$$

[2] This classification was used in Harrison et al (2008) to isolate the effect of process innovation. This is important because, as mentioned above, the empirical evidence shows that the negative effect of innovation on employment comes from process innovation.

where Y is output, L_P and L_T are the number of permanent and temporary workers, A is a Hicks-neutral technological change, α and β are the parameters measuring the reaction of permanent and temporary workers to a technological shock and $0 < \rho < 1$.[3]

For a given wage of permanent and temporary workers, W_P and W_T, and price of output, P, the firm chooses L_P and L_T to maximize its profits. The demands of permanent and temporary workers (in logs) are given by:

$$\ln(L_P) = \ln(Y) - \sigma \ln(W_P/P) + (\sigma-1) \ln(\alpha) \quad (2)$$

$$\ln(L_T) = \ln(Y) - \sigma \ln(W_T/P) + (\sigma-1) \ln(\beta) \quad (3)$$

where $\sigma = 1/(1-\rho)$ is the elasticity of substitution between L_P and L_T.

To study the effect of innovation on employment, we consider the stochastic version of labor demands (2) and (3) augmented to include product and process innovation –see Van Reenen (1997) and Piva and Vivarelli (2005) for a similar approach. The estimating equations are:

$$l_{\tau,i,t} = \beta_{1\tau}\ y_{i,t} + \beta_2\, w_{\tau,i,t} + \alpha_{1\tau}(\mathrm{L})\, prod_{i,t} + \alpha_{2\tau}(\mathrm{L})\, proc_{i,t} + c_i + v_{\tau,i,t} \qquad \tau = \mathrm{P, T} \qquad (4)$$

where: (i) $l_{\tau,i,t}$ is the log of the number of employees –permanent when τ=P and temporary when τ=T– working in firm i in period t. (ii) y_{it} is the log of the real value of production of firm i in period t. In the estimation we use its lag to avoid endogeneity. (iii) $w_{\tau,i,t}$ is the real wage of permanent (τ=P) and temporary (τ=T) workers. We do not have information of wages by type of contract. Instead of these variables we consider that firms are price takers in the labor market and therefore we include a set of industry-year dummies. These industry-year dummies also control for any time varying non-observed factor that affect all the firms in industry *j* in the same way, for example, changes in regulation and the effect of the business cycle. (iv) $prod_{it}$ is a dummy variable that takes value one if firm i introduced a new product in period t, (v) $proc_{it}$ is a dummy

[3] Van Reenen (1997) and Piva and Vivarelli (2005) also used a CES production function to study the effect of innovation on employment. However, they wrote the production function in terms of capital and labor. We are interested in the demand of permanent and temporary workers and therefore we consider the production function in terms of different type of labor. In this sense, we follow Dolado et al (2002) who used a CES production function in terms of permanent and temporary workers to study the boom of temporary jobs in Spain.

variable that takes value if firm i introduced a new process without changing its product in period t. Using innovation outcomes instead of innovation inputs like R&D expenditures is important because firms can innovate by other means different than internal R&D depending their innovation strategy. (vi) $\alpha_{1\tau}(L)$ and $\alpha_{2\tau}(L)$ are lag polynomials that reflect the fact that innovation can take a time to show the effect on employment. To avoid endogeneity we consider lag polynomials without the contemporaneous effect –i.e., lag polynomials are of the form $(\alpha_{m\tau 1}L+\alpha_{m\tau 2}L^2+\cdots+\alpha_{m\tau k}L^k)$ with $m = 1, 2$ and $\tau =$ P, T. (vii) c_i are time invariant unobserved firm characteristics possible correlated with explanatory variables, and (viii) v_{it} is an error term not correlated with explanatory variables. We also include the age of the firm (divided by 100) and its square to capture the fact young firms tend to grow faster and hire more temporary workers. The square aims at capturing nonlinearities in this relationship.

Given the correlation between c_i and the explanatory variables, we estimate equation (4) controlling by firm fixed effects using the within groups estimator. Table 3 shows the estimates of equation (4). We also included as dependent variable the total number of workers. For each dependent variable we consider two models with different lag polynomials in equation (4). In the first one, we consider k=2 and therefore we study the effect of innovations in t-1 and t-2 on current total, permanent, and temporary employment. In the second model, we consider k=3 and therefore we study the effect of innovations in t-1, t-2, and t-3 on current total, permanent, and temporary employment.

[Table 3 about here]

Table 3 shows the robust standard errors below each coefficient. The effect of innovation on the total number of employees is positive and significant both for process and product innovations. This result shows that Harrison et al (2008) findings are robust even after controlling for the effect of the business cycle, for any time-varying non-observed factors affecting homogeneously to all the firms in the same industry and time invariant non-observed firm's characteristics.

It is interesting to note that both process and product innovation generate jobs one and two years after the innovation. However, after two years of the innovations there are no additional effects on employment. Therefore, from now on we concentrate our attention in the models with only

two lags for the innovations –i.e. k=2. A product innovation increases total employment in average by 1.7 and 1.6 percent after one and two years of the innovation.[4] Similarly, a process innovation increases total employment in 1.8 and 1.4 percent after one and two years, respectively.

After one and two years of a product innovation, firms increase the number of permanent workers in average by 1.5 and 1.2 percent, respectively.[5] The effect on temporary workers is larger but only occurs one year after the innovation. According with our estimates, firms increase the number of temporary workers in average by 6.9 percent one year after a product innovation.

The effect of process innovation is similar for temporary workers. After one year of a process innovation firms increase the number of temporary workers in 9.5 percent. However, the effect on permanent workers is different; it is smaller and statistically non-significant.

4. Innovation and employment before and after 1997's EPL change

Previous findings show that Spanish manufacturing firms were reluctant to offer open-ended contracts even after two or three years of the innovation. In this section, we study how the firms' willingness to offer open-ended contracts after the innovations depends on the difference in the dismissal costs between temporary and permanent workers.

In the early eighties the unemployment rate in Spain was around 20 percent. To reduce this high level of unemployment, the EPL was changed in 1984 to allow the use of fixed-term contracts to hire unemployed workers. This reform was different than in other European countries; while in some countries fixed-terms contracts were restricted to some type of workers or sectors, the Spanish 1984 reform did not limit in any way the applicability of fixed-term contracts. With this change firms of any sector were allowed to hire workers without considering the dismissal cost

[4] Although the coefficient it is not exactly a growth rate, it is usually interpreted as a growth rate (See Wooldridge, 2002, pp. 16-17). The coefficient of the dummy variable for product innovation is equal to E[$l \mid prod=1, proc, x$] – E[$l \mid prod=0, proc, x$], this expression is equal to the difference in the expected value of logs (i.e., a growth rate) if *prod*, *proc*, and x are independent of the error term in equation (4). The coefficient of *proc* is analogous.

[5] Although the effect after two years is not statistically different from zero in the model with k=2, it is statistically significant at five percent in the model with k=3.

they would need to pay in case they need to terminate a contract. As a consequence, the level of unemployment went down but the proportion of temporary workers soared from 11 percent in 1983 to 35 percent in the early nineties. In this way, Spain became the European country with the highest proportion of temporary workers.

The high proportion of workers with fixed-term contracts was soon considered a problem and several EPL reforms aimed at reducing it. In 1994 a change in EPL restricted the use of temporary contracts to hire unemployed aged more than 45 years, disable workers, long term unemployed.[6] This reform also introduced fiscal incentives for firms offering open-ended contract to temporary workers less than 25 or more than 45 years old. This reform did not reduce the dismissal cost corresponding to open-ended contracts. The proportion of fixed-term workers continued close to 30 percent after the reform and in 1997 another reform aimed at reducing it. This reform restricted the use of fixed-term contract to disabled workers and expanded the range of workers that firms can offer open-ended contract and receive the subsidy. Importantly, this reform also reduced the cost of hiring permanent workers by reducing the dismissal cost of new permanent contracts for unemployed workers aged between 18 and 29 or more than 45, disabled or long-term unemployed workers. This new contract was called Permanent Employment Promotion Contract (PEPC). The quantity of wage's days of indemnities in case of unfair dismissal in this new type of contract was 33; 36 percent lower than the regular permanent contract that pays 45 wage's days in case of unfair dismissal.[7] In 2001, another reform extended the range of eligible workers for the PEPC to workers aged 16-29 or older than 45, women, long-term unemployed, and disabled workers. The conversion rate from fixed-term contracts into open-ended contracts remained stable around 4 percent of the total number of contracts despite the reduction of firing costs for the PEPC. For this reason, further EPL reforms took place in 2006 and 2010. Since the approval of these reforms, there has been a substantial reduction in the temporary employment rate; 24.8 percent in the first quarter of 2011. However, an important

[6] In addition to the general fixed-term contracts discussed in the text, there were two additional types of temporary contracts: Training and Apprenticeship temporary contracts. Training temporary contracts were used to hire workers with secondary education (or higher) obtained in the last four years. Apprenticeship temporary contracts were used to hire non-disabled workers aged 16-20 with less than secondary education. In 1994 the minimum term changed from three month to six. The maximum term for Training temporary contracts was reduced from three to two years. The maximum term for Apprenticeship temporary contracts was not changed; it continued in three years.

[7] Galdón Sánchez and Güell (2000) find that around 72 percent of cases that went to court were declared unfair.

share of the reduction can be attributed to the sharp downturn the Spanish economy entered after 2008 that raised the unemployment rate up to 21.3 percent in the first quarter of 2011.[8]

To analyze if after the reduction in the dismissal costs introduced in the EPL change in 1997 firms were more willing to hire permanent workers after their innovations we estimate equation (4) before and after 1997. Table 3 shows the results of these estimations. We consider 1997 because in that year the dismissal cost for new permanent contracts was reduced.

The first panel of Table 4 shows the estimations for the period 1991-1997. During this period the effect of innovation on the total number of employees was similar than for the whole period. All the impact was through temporary workers. After one year of the innovation, the number of temporary workers increased in 13.9 percent and 7.9 percent in the case of process and product innovations. The effect of process and product innovations on permanent workers one and two years after the innovation was zero.

[Table 4 about here]

The second panel of Table 4 shows the estimation for the period 1998-2005. Interestingly, after the change in the EPL in 1997 firms changed their willingness to offer open-ended contracts after the innovation. The effect of a process innovation was translated in an increase in 1.6 percent in the number of permanent workers after two years of the innovation. The effect of product innovation on permanent workers was larger; 2.3 percent after one year of the innovation and 2.6 percent after two years of the innovation. The effect of innovations on temporary workers was again concentrated one year after the innovations but was smaller than the effect before the EPL change and smaller than the effect during the whole period. In this period, one year after a product innovations firms increased the number of temporary workers in 5.3 percent (although this coefficient is non-significant) and after a process innovation in 5.2 percent. Unfortunately, our dataset do not have information about the conversion of temporary workers into permanent workers. A negative sign in the coefficient of temporary workers and a positive sign in the coefficient of permanent workers might be a signal that some temporary workers were

[8] For a more detailed analysis of the changes in the EPL see Güell and Petrongolo (2007) and Dolado et al (2008).

converted into permanent workers. After two years of the process and process innovations we observe this pattern; however, the negative sign for temporary workers is statistically non-significant.

The effect of product innovation on total employment after 1997 is similar to the effect before 1997. However, the effect of process innovation is different. After 1997 the effect of process innovation on total employment both after one and two years is not significant at 10 percent. The effect on total employment of a process innovation after one year is considerably lower than before the change in the EPL. This can be explained by the lower effect of process innovation on temporary workers which in turn shows the restrictions to fixed-term contracts introduced by the change in EPL.

Interestingly, the R-squared of the regression of permanent workers is larger after 1997. This finding tells us that innovation explains a higher proportion of the variance of the number of permanent workers. This finding also tells us that after the change in EPL firms were willing to adjust the number of permanent workers after the innovations.

5. Conclusions

In this paper we presented evidence about the effect of product and process innovation on employment in the Spanish manufacturing sector over the period 1991-2005. In 1997 the EPL was changed to reduce the proportion of temporary workers; the change in the EPL included a reduction in the dismissal cost for new permanent workers and restrictions to temporary contracts. We used this change to evaluate the effect of innovations on the number of permanent and temporary workers before and after the change in the EPL.

Our findings confirm the results of Harrison et al (2008), both product and process innovation created employment in the Spanish manufacturing sector. Moreover, we show that their findings are robust even after controlling for the effect of any time varying non-observed factor at the industry level and for time invariant non-observed firm characteristics. Additionally, we found that the effect on temporary workers was larger than on permanent workers. We also found a difference in the moment in which the effect occurs. While the effect on temporary workers takes

place only one year after the innovation, the effect on permanent workers takes place mainly two years after the innovations.

Studying the impact of innovation on employment before and after the EPL change in 1997, we found that before 1998 all the impact of innovation on employment was through an increase in temporary workers. During this period firms were reluctant to offer open-ended contracts to new workers (or to their temporary workers). However, after the EPL change the impact of product and process innovations on permanent workers were positive and significant. While product innovation increased permanent workers one and two years after the innovation, process innovation increased permanent workers only after two years of the innovation. The effect product innovation on total employment was similar before and after the EPL change. However, the effect of process innovations on total employment was considerably lower after the change in the EPL. The difference is mainly explained by the reduction in the effect of process innovation on the number of temporary workers.

Although we are focused on the effect of innovation on employment, our results show that the change in the EPL in 1997 was successful in changing the willingness of innovative firms to offer open-ended contracts after their innovations. However, they also show that the restrictions introduced on temporary contracts also affected the willingness of firms of hiring additional workers.

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Table 1: Variable definitions

Variable	Description
Product innovation (*prod*)	Dummy variable that takes value one if the firm introduced a product innovation. A product innovation is assumed to have occurred when the firm answers positively to the following request: "*Please indicate if during* [corresponding year] *your firm obtained product innovations (new products or modified products which modifications are important enough to consider them different from the previous product)*."
Process innovation (*proc*)	Dummy variable that takes value one if the firm introduced a process innovation without changing its products. A process innovation is assumed to have occurred when the firm answers positively to the following request: "*Please indicate if during* [corresponding year] *your firm introduced some significant modification of the productive process (process innovation). If the answer is yes, please indicate the way: a) introduction of new machines; b) introduction of new methods of organization; c) both.*" Process innovation takes value one if in addition to a positive answer to this question, the firm reports a negative answer for the product innovation question.
Permanent workers	Number of workers with an open-ended contract.
Temporary workers:	Number of workers with a fixed-term contract.
Total number of employees	Number of permanent and temporary workers.
Production	Real value of production. Nominal values were deflated using a firm-specific price index. Firms are asked about the price changes they made during the year in up to 5 separate markets in which they operate. The price index is computed as a Paasche-type index of the responses.
Age	Age of the firm in years computed from the difference between the current year and the constituent year reported by the firm.
Industry	18 industry dummy variables corresponding to an adaptation of a standard NACE classification. Industries are: (1) Ferrous and nonferrous metals, (2) Nonmetallic minerals, (3) Chemical products, (4) Metal products, (5) Industrial and agricultural machine, (6) Office and data processing machine, (7) Electrical and electronic goods, (8) Vehicles, cars and motors, (9) Other transport equipment, (10) Meat and preserved meat, (11) Food and tobacco, (12) Beverages, (13) Textiles and clothing, (14) Leather and shoes, (15) Timber and furniture, (16) Paper and printing products, (17) Rubber and plastic products, (18) Other manufacturing products.

Table 2: Descriptive Statistics

	SMEs (less than 200 empl.)		Large firms (more than 200 empl.)	
	Mean	**Std. Dev**	**Mean**	**Std. Dev**
A. All firms (2,372 firms; 20,399 observations)				
Permanent Workers	36.56	42.92	633.44	1239.39
Temporary Workers	9.90	16.87	94.14	197.42
Age	18.92	16.74	36.09	23.22
Product innovation	0.20	0.40	0.40	0.49
Process innovation	0.16	0.37	0.22	0.42
B. Firms that do not innovate between 1991 and 2005 (461 firms; 2,983 observations)				
Permanent Workers	25.50	33.85	467.70	636.20
Temporary Workers	7.44	11.55	63.17	108.91
Age	16.92	16.45	31.32	21.42
Product innovation	-	-	-	-
Process innovation	-	-	-	-
C. Firms with at least one product or process innovation between 1991 and 2005 (1,911 firms; 17,416 observations)				
Permanent Workers	39.17	44.39	641.59	1261.11
Temporary Workers	10.48	17.85	95.66	200.65
Age	19.39	16.78	36.32	23.28
Product innovation	0.24	0.43	0.42	0.49
Process innovation	0.20	0.40	0.23	0.42

Table 3: The effect of innovation on employment

	Total number of workers		Permanent workers		Temporary workers	
	k=2	**k=3**	**k=2**	**k=3**	**k=2**	**k=3**
Only process innovation (t-1)	0.018***	0.015**	0.009	0.007	0.095***	0.090***
	[0.006]	[0.006]	[0.007]	[0.008]	[0.024]	[0.026]
Only process innovation (t-2)	0.014**	0.009	0.010	0.010	-0.003	-0.012
	[0.006]	[0.006]	[0.007]	[0.007]	[0.022]	[0.023]
Only process innovation (t-3)	-	0.007	-	-0.001	-	-0.008
		[0.006]		[0.008]		[0.024]
Product innovation (t-1)	0.017***	0.016**	0.015*	0.020**	0.069***	0.060**
	[0.006]	[0.007]	[0.008]	[0.008]	[0.025]	[0.027]
Product innovation (t-2)	0.016***	0.015**	0.012	0.014**	0.002	0.013
	[0.006]	[0.006]	[0.007]	[0.007]	[0.024]	[0.024]
Product innovation (t-3)	-	-0.002	-	-0.004	-	-0.029
		[0.007]		[0.008]		[0.025]
Production (t-1, in logs)	0.464***	0.468***	0.440***	0.444***	0.459***	0.444***
	[0.019]	[0.021]	[0.022]	[0.023]	[0.045]	[0.051]
Age/100	2.130***	2.112***	3.769***	3.677***	-3.703	-2.967
	[0.588]	[0.667]	[0.708]	[0.722]	[3.389]	[3.212]
Age/100 squared	-2.158***	-2.099***	-3.722***	-3.511***	1.291	1.543
	[0.307]	[0.330]	[0.371]	[0.396]	[1.100]	[1.205]
Industry x Year dummies	yes	yes	yes	yes	yes	yes
Firm level fixed effects	yes	yes	yes	yes	yes	yes
R-squared	0.37	0.37	0.33	0.34	0.10	0.09
Number of observations	15,912	13,692	15,912	13,692	15,912	13,692
Number of firms	2,350	2,082	2,350	2,082	2,350	2,082

Notes: (1) All dependent variables are in logs, (2) Robust standard errors in brackets, (3) *** p<0.01, ** p<0.05, *p<0.1.

Table 4: The effect of innovation on employment before and after the policy change

	Total number of workers	Permanent workers	Temporary workers
A. Sample Period: 1991-1997			
Only process innovation (t-1)	0.026***	0.012	0.139***
	[0.007]	[0.009]	[0.036]
Only process innovation (t-2)	0.01	-0.002	0.015
	[0.007]	[0.008]	[0.032]
Product innovation (t-1)	0.013*	-0.008	0.079**
	[0.007]	[0.010]	[0.039]
Product innovation (t-2)	0.021***	-0.005	0.038
	[0.008]	[0.009]	[0.036]
Production (t-1, in logs)	0.250***	0.190***	0.358***
	[0.018]	[0.022]	[0.060]
Age/100	3.765***	5.211***	-0.749
	[1.157]	[1.191]	[14.021]
Age/100 squared	-3.152***	-4.376***	-4.275
	[0.569]	[0.681]	[2.932]
Industry x Year	yes	yes	yes
Firm level fixed effects	yes	yes	yes
R-squared	0.15	0.08	0.07
Number of observations	6,441	6,441	6,441
Number of firms	1,709	1,709	1,709
B. Sample Period: 1998-2005			
Only process innovation (t-1)	0.007	0.009	0.052*
	[0.007]	[0.009]	[0.030]
Only process innovation (t-2)	0.011	0.016*	-0.005
	[0.007]	[0.009]	[0.027]
Product innovation (t-1)	0.018**	0.023**	0.053
	[0.008]	[0.009]	[0.033]
Product innovation (t-2)	0.017**	0.026***	-0.017
	[0.007]	[0.008]	[0.030]
Production (t-1, in logs)	0.404***	0.401***	0.343***
	[0.023]	[0.025]	[0.056]
Age/100	0.751	3.205***	-9.39
	[0.815]	[0.857]	[6.837]
Age/100 squared	-1.320***	-3.198***	2.27
	[0.414]	[0.475]	[1.585]
Industry x Year	yes	yes	yes
Firm level fixed effects	yes	yes	yes
R-squared	0.29	0.27	0.08
Number of observations	9,471	9,471	9,471
Number of firms	1,768	1,768	1,768

Notes: (1) All dependent variables are in logs, (2) Robust standard errors in brackets, (3) *** p<0.01, ** p<0.05, *p<0.1.