Employment, Innovation and Productivity: Evidence from Italian Microdata

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Abstract

Italian manufacturing firms have been losing ground with respect to many of their European competitors. This paper presents some empirical evidence on the effects of innovation on employment growth and therefore on firms' productivity with the goal of understanding the roots of such poor performance. We use firm level data from the last three surveys on Italian manufacturing firms conducted by Mediocredito-Capitalia, which cover the period 1995-2003. Using a modified version of the model proposed by Harrison, Jaumandreu, Mairesse and Peters (2005), which separates employment growth rates into those associated with old and new products, we provide robust evidence that there is no employment displacement effect stemming from process innovation. The sources of employment growth during the period are split equally between the net contribution of product innovation and the net contribution from sales growth of old products. However, the contribution of product innovation is somewhat lower than that for the four comparison European countries considered by Harrison *et al.*

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1 Introduction

Italian manufacturing firms have been losing ground with respect to many of their European competitors. This weak performance is not entirely attributable to the preponderance of traditional sectors, more exposed to competition from emerging countries: not only do the advanced sectors account for smaller shares of employment than in other countries, but they also display a significant negative productivity growth differential (see Lotti and Schivardi, 2005 and IMF, 2006). Also, many indicators of innovation activity, both in terms of input and output, signal that the Italian economy is lagging behind. Can this lower innovative activity account for slower productivity growth in Italian manufacturing? Or are other factors, such as labor market rigidity, at work?

This paper presents some empirical evidence on the effects of innovation on employment growth and therefore on firms' productivity, with the goal of contributing to our understanding the roots of such poor performance. We use a simple theoretical framework pioneered by Harrison *et al.* (2005) to disentangle the effects of innovation on employment and productivity growth applied to a panel of nearly 9,500 Italian firms observed over a nine year period (1995-2003). These data come from the last three surveys of Italian manufacturing firms conducted by Mediocredito-Capitalia (hereafter MCC), covering the period 1995-2003. These surveys contain balance sheets items and, more importantly, qualitative information on firm characteristics, with a strong focus on innovation activities. Using instrumental variable regressions to correct for the endogeneity of our innovation measures, we provide robust evidence that there is no employment displacement effect stemming from process innovation and that product innovation contributes about half the employment growth in these firms during the period. Sales growth of old products accounts for the other half of employment growth, although on average, old products do experience some efficiency gain in production so the growth comes from sales expansion.

In the next section of the paper we discuss the prior empirical evidence on innovation and employment growth. We then present the model we use for estimation, and discuss the measurement issues raised by the data that is available to us. This is followed by a presentation of the data and the results of estimating the model on our sample of firms. In the final sections of the paper we compare our results to those of Harrison *et al.* (2005) for France, Germany, Spain, and the U.K. and draw some conclusions.

2 Theoretical and empirical underpinnings

The debate about the impact of technological change on employment is a rather old one (Say, 1803; 1964 edition); since that time, scholars have been trying to disentangle the displacement and compensation effects of innovation both from a theoretical and an empirical point of view, often pointing out the different implications of process and product innovation. The introduction of a new or significantly improved product increases demand, and therefore an increase in the employment levels of innovating firms. Nevertheless, the innovating firm, enjoying temporary market power, may set profit-maximizing prices and reduce output enough so that the net effect after substitution to the new good is negative for the firm's output. On the other hand, even though process innovation is typically labor-saving, its effect on employment is not straightforward. If the same amount of output can be made with fewer workers, the firm can share this efficiency gain with the consumers via lower prices, thereby increasing demand. Depending on market structure, the demand elasticity, and the elasticity of substitution between capital and labor, compensation mechanisms can counterbalance the labor saving effect of process innovation (for a detailed survey on the compensation mechanisms, see Spiezia and Vivarelli, 2002).

From an empirical perspective and because firms are often involved in product and process innovation together, the identification of displacement and compensation effects becomes even more difficult. Nevertheless, the empirical literature on the effects of innovation on employment has been increasing since the 1990s, when micro-economic data on individual firms began to be widely available and econometric techniques which are robust to simultaneity and endogeneity problems were developed.[1]

While there is a widespread consensus on the positive impact of product innovation on employment at the firm-level, the evidence about process innovation is less clear-cut. Using cross-sectional data for Germany, Zimmermann (1991) finds that technological progress was responsible for the fall of employment during the 1980s, while Entorf and Pohlmeier (1990) find no significant effects. Thanks to the availability of surveys with a time dimension, Brower *et al.* (1993) find a positive effect of product innovation on employment growth for the Netherlands in the 1980s, but a negative one for total R&D. Using the Community Innovation Survey (CIS) data for Germany, Peters (2004) finds

[1]See Van Reenen (1997), Chennels and Van Reenen (2002), Hall and Kramarz (1998) and Lachenmaier and Rottmann (2006).

a significantly positive impact of product innovation on employment, and a negative one for process innovation. In contrast, Blechinger *et al.* (1998) supports the evidence of a positive relationship between both product and process innovation and employment growth in the Netherlands and in Germany. Blanchflower and Burgess (1998) and Doms *et al.* (1995) find a positive impact of process innovation on employment growth in the U.K. and in Australia and in the US, respectively, whereas the study by Klette and Forre (1998) does not find a clear relation between innovation and employment in Norway. The paper by Harrison *et al.* (2005), which is closest to our work and serves as a model for it, uses CIS data for France, Germany, U.K., and Spain. These authors find that although process innovation displaces employment, compensation effects from product innovation seem to dominate, albeit with some differences across countries.[2] Greenan and Guellec (2000), also combining firm-level panel data with innovation surveys, find that innovating firms (and industries) have created more jobs than non-innovating ones. Piva and Vivarelli (2005), combining different surveys by Mediocredito-Capitalia from 1992-1997, build a balanced panel of 575 Italian Manufacturing firms and find a small but significant positive relation between innovative investments and employment. However, they did not use the usual classification of innovation in product and process, but instead used investments aimed at introducing new innovative equipment, which corresponds to embodied technological change and is somewhat closer to process innovation. Summarizing these results, most studies have found positive effects of product innovation on employment, but the evidence on process innovation is mixed. For European firms, process innovation usually has a small negative or no effect on employment, although for non-European countries (the U.S. and Australia) it is more likely to be positive. However, the overall effect of innovation on employment is generally positive in these studies.

3 A model of innovation and employment

3.1 The theoretical framework

The model presented here is the one described in the paper by Harrison et al. (2005, henceforth HJMP 2005), which is specifically tailored for the type of innovation data available to us. In this framework, a firm produces two kinds of products at time t: old or

[2] A comparison of our results with those in Harrison et al. is presented in Section 5.

only marginally modified products ("old products", denoted Y_{1t}) and new or significantly improved products ("new products", Y_{2t}). Firms are observed for two periods, $t = 1$ and $t = 2$ and innovation occurs between the two periods (if it occurs at all). Therefore by definition, in the first period, only old products are available (Y_{11}), so that $Y_{21} = 0$.

We assume that each type of product is made with an identical separable production technology that has constant returns to scale in capital, labor and intermediate inputs. Each production technology has an associated efficiency parameter that can change between the two periods. New products can be made with higher or lower efficiency with respect to old products, and the firm can affect the efficiency of its productions over time through investments in process innovation. The production function for a product of type i at time t is the following:

$$Y_{it} = \theta_{it} F\left(K_{it}, L_{it}, M_{it}\right), \quad i = 1, 2; \;\; t = 1, 2. \tag{1}$$

where θ represents efficiency, K, L and M are capital, labor and materials, respectively.[3] The firm's cost function at time t can be written as:

$$C\left(w_{1t}, w_{2t}, Y_{1t}, Y_{2t}, \theta_{1t}, \theta_{2t}\right) = c\left(w_{1t}\right) \frac{Y_{1t}}{\theta_{1t}} + c\left(w_{2t}\right) \frac{Y_{2t}}{\theta_{2t}} + F \tag{2}$$

where $c\left(w\right)$ is the marginal cost as a function of the price vector w, and F represents the fixed costs. According to Shephard's Lemma:

$$L_{it} = c_L\left(w_{it}\right) \frac{Y_{it}}{\theta_{it}} \tag{3}$$

where $c_L\left(w_{it}\right)$ represents the derivative of the marginal cost with respect to the wage.

The employment growth from period $t = 1$ to period $t = 2$ can be decomposed in two terms: the contribution to growth from the old products and the contribution from the new products.[4]

The decomposition looks as follows:

$$\frac{\Delta L}{L} = \frac{L_{12} - L_{11}}{L_{11}} + \frac{L_{22} - L_{21}}{L_{11}} = \frac{L_{12} - L_{11}}{L_{11}} + \frac{L_{22}}{L_{11}} \tag{4}$$

[3]We observe neither capital nor materials in our data so these factors are omitted in the rest of the paper and our measurement concerns labor productivity only.

[4]As we show later, this decomposition corresponds to the share-weighted sum of growth rates when both products exist in both periods, but not when the new products only exist in the second period.

because there are no new products at time $t = 1$ and $L_{21} = 0$. We also assume that the derivative of the marginal cost with respect to wage does not change over time, i.e. $c_L(w_{11}) = c_L(w_{12}) = c_L(w_1)$. Using the results of equation (3), the growth rate in equation (4) can be approximated as:

$$\frac{\Delta L}{L} \simeq -\left(\frac{\theta_{12} - \theta_{11}}{\theta_{11}}\right) + \left(\frac{Y_{12} - Y_{11}}{Y_{11}}\right) + \frac{c_L(w_2)}{c_L(w_1)} \frac{\theta_{11}}{\theta_{22}} \frac{Y_{22}}{Y_{11}} \quad (5)$$

According to equation (5), employment growth is determined by three terms. The first is the rate of change in efficiency in the production of old products: it is expected to be larger for those firms that introduce process innovations related to old product production. The second term is the growth of old product production, while the third is the labor increase from expansion in production due to the introduction of new products.

Assuming that the derivative of marginal cost with respect to the wage is equal for old and new products, that is, that $c_L(w_1) = c_L(w_2)$, then the effect of product innovation on employment growth depends on the relative efficiency of the production processes of old and new products. If new products are made more efficiently than old ones, this ratio is less than unity, and employment does not grow at the same pace as the output growth accounted for by new products.

3.2 Estimation strategy

Equation (5) implies the following estimation equation:

$$l = \alpha_0 + y_1 + \beta y_2 + u \quad (6)$$

where l is the growth rate of employment between $t = 1$ and $t = 2$, y_1 is the contribution of old products to output growth $\left(\frac{Y_{12} - Y_{11}}{Y_{11}}\right)$, and y_2 is the contribution of new products to output growth $\left(\frac{Y_{22}}{Y_{11}}\right)$. u is a random disturbance expected to have zero mean conditional to a suitable set of instruments. In this specification, the parameter α_0 represents the negative of the average efficiency growth in the production of the old product (i.e., labor productivity growth), while the parameter β measures the marginal cost in efficiency units of producing new products relative to that for old products. If β is equal to unity, efficiency in the production of old and new products is the same; if $\beta < 1$, new products are produced more efficiently.

Because process innovation can affect changes in the efficiency of both old and new products, equation (6) can be easily modified to take this feature into account as follows:

$$l = (\alpha_0 + \alpha_1 d_1) + y_1 + (\beta_0 + \beta_1 d_2)\, y_2 + u \tag{7}$$

where d_1 and d_2 are dummy variables which take value one if the firm introduced process innovation related to the production of old and new products respectively. Because it is impossible to know from the survey what share of its process innovation the firm devotes to new versus old products, in the empirical exercise we will experiment with different alternatives ($d_1 = 1, d_2 = 0$ and $d_1 = 0, d_2 = 1$).

Simply by rearranging equation (7), it is possible to obtain the usual labor productivity equation as:

$$y_1 + y_2 - l = -\alpha_0 - \alpha_1 d_1 - (1 - \beta_0) - \beta_1 d_2 y_2 - u \tag{8}$$

which is helpful in interpreting the magnitude and the sign of the estimated coefficients (the dependent variable is the growth of real output per worker).

Despite its simplicity, equation (6) can capture two effects of innovation. First, under the assumption that y_2 is observable, it identifies the gross effect of product innovation on employment. Second, if process innovation related to old products is observed, it allows us to identify directly the productivity (or displacement) effect of process innovation on employment.[5]

3.3 Measurement issues

In order to estimate equation (6), we must approximate real production (Y_1 and Y_2) with nominal sales, and this creates a measurement problem. Nominal sales encompass the effects of price changes, but real production as well is affected by price movements via demand adjustment mechanisms. Moreover, old and new products' prices do not necessarily have the same patterns of change and, more importantly, they are unobservable

[5] It is worth noting that the variable y_1 encompasses three different effects: an "autonomous" variation in the demand of old products, due to exogenous market conditions; a "compensation" effect induced by a price variation following process innovation, and a "substitution" effect stemming from the introduction of the new products. Unfortunately, without additional data on the demand side, it is impossible to disentangle these effects.

in the data available to us. In this section of the paper we show that using nominal sales growth instead of real output growth in our equation implies that the coefficient of growth due to new products combines two effects: the relative efficiency of producing the new and old products and their relative price or quality differences.

To show this, define the nominal growth rate of sales of old products g_1 and the rate of increase of their prices π_1 as follows:

$$g_1 = \frac{P_{12}Y_{12} - P_{11}Y_{11}}{P_{11}Y_{11}} \qquad \pi_1 = \frac{P_{12} - P_{11}}{P_{11}} \tag{9}$$

Then we can approximate y_1 as $(g_1 - \pi_1)$. Also define the nominal growth rate of sales of new products g_2 and the difference in the prices of the new products with respect to the old products as follows:

$$g_2 = \frac{P_{22}Y_{22}}{P_{11}Y_{11}} \qquad \pi_2 = \frac{P_{22} - P_{11}}{P_{11}} \tag{10}$$

These definitions imply that $y_2 = \frac{g_2}{(1+\pi_2)}$. Substituting g_1 and g_2 for y_1 and y_2, which are not observable, equation (6) becomes the following:

$$l - (g_1 - \pi_1) = \alpha_0 + \beta \frac{g_2}{1+\pi_2} + u \tag{11}$$

Unfortunately equation (11) is still not suitable for estimation, because neither π_1 nor π_2 are directly observed. What is observed are sectoral-level prices in two periods, where the price in the second period is in fact some unknown weighted average of old and new product prices. If we express these unobserved prices in terms of the observed prices, so that $P_{21} = (1+\varphi_1)\, P_2$ and $P_{22} = (1+\varphi_1)\, P_2$, then we can show that the observed growth of prices π is related to π_1 and π_2 as follows:

$$\begin{aligned} \pi_1 &= \pi + \varphi_1 (1+\pi) \\ \pi_2 &= \pi + \varphi_2 (1+\pi) \end{aligned} \tag{12}$$

where φ_1 and φ_2 are the percent differences between the "true" price of the old and new products and the observed price obtained from the statistical agency. The observed price is some weighted combination of the two prices that probably does not include adjustments for all the quality change between the periods. Note also that in principle φ_1 and φ_2 vary across firms because the price deflators are available only at the sectoral level.

Replacing π_1 and π_2 by π , the estimating equation becomes:

$$l - (g_1 - \pi) = \alpha_0 + \frac{\beta}{1 + \varphi_2} \frac{g_2}{(1 + \pi)} + [u - \varphi_1 (1 + \pi)] \tag{13}$$

This equation expresses the growth in measured real labor productivity as a function of the growth in real new products, measured using the observed deflator. Compared to equation (11), there are two important differences: first, the coefficient of the new product term is the ratio of β, the relative efficiency of producing new versus old products, to $(1 + \varphi_2)$, the ratio of the quality-adjusted price of the new products to the share-weighted price of old and new products. If there is substantial quality improvement in the new product whose cost is passed on to consumers, φ_2 will be greater than zero and the pass-through from its sales growth to real labor productivity will be moderated relative to the case of little quality change. On the other hand, if quality improvement leads to lower "effective" prices, φ_2 will be less than zero, and new product sales will have an enhancing effect on real labor productivity. This result is analogous to one in Griliches and Mairesse (1984) for the production function: innovation and R&D can either improve efficiency (declines in β) or increase quality (increases in φ_2). Without good information on quality-adjusted prices, we cannot separate the two effects.

The second difference in equation (13) is in the disturbance, which now contains a term $\varphi_1 (1 + \pi)$. We expect this term to be quite small, because the measured prices are likely to be close to the prices of old products, both because of statistical agency inertia and because old products make up a large share of sales on average, implying a f1 that is near zero. Nevertheless, the term does introduce some more endogeneity into the equation, beyond that due to the simultaneous choice of labor input and firm output. The disturbance is now also correlated with measured deflation (via π) and with the share of new products (via φ_1). There is little that can be done about the latter problem other than to point out that the impact of the new product share will be very small.

4 The data

The data we use come from the 7^{th}, 8^{th}, and 9^{th} waves of the "Survey on Manufacturing Firms" conducted by Mediocredito Centrale (MCC). These three surveys were carried out in 1998, 2001, and 2004 using questionnaires administered to a representative sample of Italian manufacturing firms. Each survey covered the three years immediately prior (1995-1997, 1998-2000, 2001-2003) and although the survey questionnaires were not identical in all three of the surveys, they were very similar. All firms with number of employees above 500 were included, whereas smaller firms were selected using sampling stratified by geographical area, industry, and firm size.

We merged the data from the three surveys, excluding from the sample firms with incomplete information or with extreme observations for the variables of interest.[6] The final sample is an unbalanced panel of about 13,000 observations on 9,500 firms, of which only 608 are present in all three years.[7]

Simple statistics for both the unbalanced and balanced panels are presented in Tables 1 and 2. Tables 1 shows the characteristics of the sample for the three periods separately and then pooled together, whereas Table 2 shows various subsets of the sample: R&D-doing firms only, innovating firms only, and firms in high and low technology sectors. The first thing to note from these tables is that the balanced panel is in fact quite similar to the unbalanced panel. Although slightly more of them do R&D and innovate, the median R&D intensity for those who do R&D is actually higher in the unbalanced panel. The median firm in our unbalanced panel has 33 employees and sales of 154,000 euros per employee. 60 per cent perform R&D during the three years of the survey and 60 per cent innovate, either in processes or products. Those that do R&D have a median R&D intensity of 2.7 per cent and 81 per cent innovate at least once in the three years. The R&D-doing and innovating firms are somewhat larger than the other firms. Finally, although substantially fewer of the firms in low technology industries do R&D (29 versus 52 per cent), only slightly fewer innovate (56 versus 67 per cent).

[6] We required sales per employee between 2000 and 10 million euros, growth rates of employment and sales of old and new products between -150 per cent and 150 per cent, and R&D employment share less than 100 per cent. We also replaced R&D employment share with the R&D to sales ratio for the few observations where it was missing.

[7] An earlier version of this paper presented results using the balanced panel of 466 firms. There were few differences between those results and those presented here, so we prefer to present results for as large a sample as possible.

Equation (13) requires measures of g_1 and g_2, the sales growth attributed to old and new products respectively. We observe g, the growth of nominal sales, and s, the share of sales in the second period that are due to new products. Given the definitions in equations (9) and (100), these two growth rates are given by the following formulas:

$$\begin{aligned} g_1 &= (1 - s)\, g - s \\ g_2 &= s\,(1 + g) \end{aligned} \tag{14}$$

Note that these two growth rates sum to g directly, without share weighting, so that strictly speaking, they should be interpreted as the contribution to growth from the two sources, rather than as growth rates themselves.

5 Results

The results of estimating the models in equations (11) and (13) are shown in Tables 4 and 5. However, before discussing these results, we begin by presenting results for a simple descriptive regression of three-year employment growth on three-year real sales growth and dummies for innovation during the same three year period (process innovation only, product innovation only, and both process and product innovation). These results are presented in Table 3, first for our three time periods separately, and then pooled over the three periods, but with separate intercepts for each period. Tests of slope and dummy coefficient equality over time are generally accepted. Price changes were approximated by a set of two digit industry price deflators and industry dummies at the two digit level were included in all the regressions. As we are interested in preserving the value of the intercept, we apply a linear constraint to these dummies so that the estimated sum of the coefficients is equal to zero (Suits, 1957) and the intercept corresponds to the overall mean effect.

The coefficient of real sales growth is always significant and well below unity, suggesting that for non-innovating firms, employment growth is substantially dampened relative to the growth of real sales. However, the growth rate of employment for innovating firms is much higher. With the exception of product innovation in the first period, the coefficients of all three innovation dummies are positive in all waves and increase over the three periods, although they are rarely significantly different from zero. For the pooled estimates, if sales growth increases by one per cent, non-innovators' employment increases 0.23 per cent. However, firms that introduce new processes but not new products have an average growth of employment that is 0.7 per cent higher than non-innovative firms whereas firms that introduce new products without new processes have an average growth of employment that is 1.1 per cent higher. Those that innovate in both ways have a growth of employment 2.1 per cent higher. Clearly innovation is associated with increases in employment. However, for the reasons described in section 2, all these estimates are likely to be downward biased.

Table 4 contains OLS and IV estimates of the model described in equation (11), where the left hand variable is the employment growth rate minus the growth rate of the sales due to old products ($l - (g_1 - \pi)$). The instruments for the sales growth due to new products are a dummy variable for positive R&D expenditures during the last year covered by the survey, its lagged value, the R&D employment intensity during the period, and a dummy variable for whether the firm assigned high or medium importance to developing a new product as the goal of its investment. For the IV regressions, the coefficient of the sales growth due to new products is not significantly different from one, implying that no significant differences exist between the efficiency levels of production of old and new products. The negative of the constant term gives an estimate of the average productivity growth of the old products: 4.0% from 1995 to 1997, 5.8% from 1998 to 2000, and -1.8% from 2001 to 2003. In Tables 4a and 4b we show that the productivity slowdown in the latter period occurred equally in high tech and low tech industries, but also that there was a substantial higher productivity gain in the low tech sector during the middle (1998-2000) period. We also note that unlike the sample as a whole, the high tech sector exhibits evidence either of greater efficiency in producing new products ($\beta < 1$) or quality increases that are passed on to consumers in the form of higher prices for new products ($\varphi_2 > 0$), or both.

In 5 we extend the specification to take into account process innovation, in the spirit of model (13). It should be kept in mind that at this stage, it is impossible to quantify how much of the process innovation is devoted to old or to new products, and for this reason, alternative specifications will be tested. In the upper panel, it is assumed that all process innovation goes to the old products, since we consider only process innovation of those firms with no product innovation. In this framework, a negative coefficient for the variable process innovation only would indicate an increase in the productivity of manufacturing the old products and a displacement of employment. The results are rather contradictory, with both negative and positive coefficients. However, they are always statistically insignificant, which implies that process innovation has no impact on productivity.

In the last two panels of Table 5 we add product innovation, trying to separate two different cases: in the central panel is assumed that all process innovation of product innovators goes to the old products, while in the last panel it is assumed to be devoted to new products. Of course, these represent two extreme cases, and the true allocation of process innovation between old and new product lies somewhere in the middle. The results are rather disappointing - in all cases, the only variable that is significantly related to employment growth is the growth of sales of new products, with a coefficient of unity. The conclusion is that there is no difference in the efficiency with which old and new products are produced, regardless of whether the firm undertakes process innovation during the same three year period or not. In these specifications, the constant term (the estimate of the average productivity growth of the old products) displays the same pattern as in Table 4, showing that non-innovators did lose employment on average between 1995 and 2003. Results shown in the Appendix confirm these patterns for low and high tech industries separately (Tables A8 and A9).

5.1 A rough comparison with France, Germany, Spain and the U.K.

A similar analysis has been carried out by Harrison *et al.* (2005) for France, Germany, Spain and the U.K. using data from the third Community Innovation Survey, which covers the period 1998-2001. Even though the sample design and the questionnaire are slightly different from ours, it is still worthwhile to compare their estimates with the results obtained for Italy. Table 6 presents the results of estimating a model that is exactly the same as that used by Harrison *et al.* (2005):

$$l - (g_1 - \pi) = \alpha_0 + \alpha_1 d + \beta g_2 + v \quad (15)$$

The results are very similar to those in the top panel of Table 5, although the intercept (the negative of the average productivity gain adjusted for industrial composition change) is slightly lower, which implies that the average productivity gain net of process innovation and growth in new product sales is higher when the new product sales are not adjusted for inflation. Table 7 contains a comparison of the results of Table 6 and the results of a corresponding specification from in Harrison *et al.* (2005).[8]

The sample sizes are roughly comparable, although the instruments used are slightly different: the Harrison *et al.* paper uses only a dummy variable for the impact of innovation on increasing the range of products offered, as reported by the firm. Comparing the results for Italy with those for other countries, the coefficient of the sales growth due to new products is very similar and around one for all the countries, although significantly less than one for Italy, which implies that firms became less efficient in producing new products during the period. The coefficient of the process innovation dummy is negative and significant for Germany and the U.K., indicating an increase in productivity of the old products; for France and Italy it is insignificantly different from zero, while for Spain is positive and significant. Harrison *et al.* explain the Spanish result with a possible large pass-through of any productivity improvements to prices. For the period 1998-2001, the intercept is negative for all the countries, with the highest values for Germany, Italy, and Spain. Thus it appears that firms producing old but not new products that did no process innovation experienced declines in employment during the period, not surprisingly. Process innovation alone seems to have produced efficiency gains only in Germany and the U.K., whereas the employment effect of the growth in sales of new products was neutral, implying neither greater nor lesser efficiency in their production than in that of old products in all countries.

5.2 A simple (but effective) employment growth decomposition

Another way to summarize the results of the previous section is to decompose employment growth into several components:

[8]These results come from the first panel of Table 6 of that paper.

$$
l = \begin{cases} \sum_j \left(\hat{\alpha_0} + \hat{\alpha_{0j}}\right) Dind_j + & \text{ind-specific productivity trend in old products;} \\ \hat{\alpha_1} d + & \text{due to process innovation in old products;} \\ \left[1 - 1\left(g_2 > 0\right)\right]\left(g_1 - \hat{\pi}\right) + & \text{due to output growth of old products;} \\ 1\left(g_2 > 0\right)\left(g_1 - \hat{\pi} + \hat{\beta}\frac{g_2}{1+\hat{\pi}}\right) + & \text{due to product innovation (net of substitution);} \\ \hat{u}, & \text{zero sum residual component.} \end{cases} \tag{16}
$$

$Dind_j$ are industry dummies, the $\hat{\alpha}$s and $\hat{\beta}$s are the estimated coefficients of the specification in the first panel of Table 6, and d is a dummy variable which takes the value one if the firm has introduced process innovation but not product innovation. Accordingly, for each firm, the first component accounts for the industry-specific productivity trend in the production of old products. The second component is the change in employment due to the net effect of process innovation in the production of old products, while the third is the change due to output growth of old products of those firms which did not introduce product innovation. The fourth term is the net contribution to employment growth of product innovation, after adjustment for any substitution effect of old and new products. The last component is a zero-mean residual.

The results of this decomposition for all industries are reported in Table 8, for each period separately and then pooled. We focus the discussion on the pooled analysis. Average annual employment growth during the whole period was 3.2 per cent. About half of this growth (1.7 per cent) is accounted for by new product innovations, net of the induced substitution away from old products, and the remainder (1.5 per cent) by changes in the efficiency of producing old products. Incremental process improvements in the production of old products reduce employment by a small amount (-0.2 per cent) whereas changes attributable to industry-specific deviations from the main trend are -2 per cent. These productivity enhancing effects are completely cancelled by the 4.1 per cent increase in employment associated with the production of old products by non-innovating firms. In other words, productivity among non-innovators fell enough to cancel all the employment growth in innovators during the period.

Table 9 contains a comparison of the decomposition exercise sketched above based on the results of Table 6 with the results for France, Germany, Spain and the United Kingdom (drawn from Table 10 of the Harrison *et al.* 2005 paper). As in Table 7, the period considered is 1998-2000, to maintain comparability with the Harrison *et al.* paper. In that period, firm-level employment growth in Italy is somewhat lower than in the other countries, as is the contribution of new product innovation to employment growth (2.4 per cent in Italy versus number ranging from 3.9 in the U.K. to 8.0 in Germany). Otherwise, the decompositions are rather similar. The sum of the contributions of old products to employment growth is quite positive in France and the U.K. (2.8 per cent), approximately zero in Italy and Spain, and negative in Germany (-2.1 per cent). However these effects are composed of a substantial decline due to increased average productivity and increases due to output growth of old products in firms not introducing product innovations. The conclusion from this comparison is that firm employment growth in Italy during this period is worse than that in the other countries primarily because there was lower net employment growth from the introduction of new products in the average firm.

6 Conclusions

In this paper we derived a simple model for employment growth, in which is possible to disentangle the roles of displacement and compensation effects of innovation on employment growth at the firm level. Comprehending this mechanism is of primary importance: as HJMP (2005) point out, the firm-level effects of innovation on employment are likely to determine the extent to which different agents within the firm behave with respect to innovation. Managers and workers have different incentives, and their behavior can foster or hamper innovation and technology adoption within the firm. Understanding how these mechanisms work at the firm-level is central for the design of innovation policy and for predicting how labor market regulation can affect the rate of innovation.

Using data from the last three surveys on Italian manufacturing firms conducted by Mediocredito-Capitalia, covering the period 1995-2003, we estimate alternative models of employment growth and we provide robust evidence that process innovation does not have a displacement effect in Italian firms. Moreover, we find that the average productivity growth for existing products has been increasing until 2000 and declining thereinafter, signaling a widespread inability of Italian manufacturing firms to reallocate employment in order to fully exploit productivity gains stemming from process innovation. Comparing these results with the ones of HJMP (2005) for France, Germany, Spain and the U.K. indicates that the displacement effect for process innovation in all countries is quite small, and significant only for Germany and the U.K. Although partial, this evidence suggests that Italian firms (and possibly French and Spanish firms) are not able to obtain productivity benefits from process innovation because of labor market rigidities.

We also find that on net, about half of employment growth in Italy during the 1994-2003 period is contributed by product innovation and the other half by the sales growth of old products net of their productivity gains. Finally, although there are substantial productivity gains in the production of old products overall in Italy, these are more than cancelled by output growth in firms that did not introduce new products. As other researchers have found, the overall conclusion is that process innovation has little displacement effect in Italy and product innovation increases employment. However, the productivity decline during the period seems to come largely from non-innovating firms.

In future, we hope to exploit the time dimension in our data further using a more structural model of innovation, employment and productivity in a panel data framework.

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Table 1: Descriptive statistics. All industries, cross section and pooled sample (unbalanced and balanced panel).

UNBALANCED SAMPLE	**1995-1997**	**1998-2000**	**2001-2003**	**1995-2003**
Number of firms	4290	4618	4040	12948
% firms doing R&D	35.57	41.4	48.44	59.47
% firms doing innovation	73.10	46.51	59.80	59.57
R&D exp. over sales (%)	1.70	1.94	1.73	1.79
R&D exp. per employee (in th. euro)	2.69	3.22	3.16	3.05
Sales/empl: mean/median (in th. euro)	185.74/139.29	189.63/143.76	247.06/187.98	206.26/154.08
Share of innovative sales (%)	5.39	9.99	9.62	8.33
Num. of employees: mean/median	116.30/34	88.24/25	142.43/49	114.45/33
% of firms with process innovation	66.27	37.31	42.65	48.57
% of firms with product innovation	30.02	24.82	41.63	31.79
% of firms with process innovation only	43.08	21.70	18.17	27.68
% of firms with process & product innov.	23.19	15.61	24.48	20.89
BALANCED SAMPLE	**1995-1997**	**1998-2000**	**2001-2003**	**1995-2003**
Number of firms	608	608	608	1824
% firms doing R&D	37.99	58.88	49.51	48.79
% firms doing innovation	75.33	53.95	60.53	63.27
R&D exp. over sales (%)	1.54	1.92213	2.10	1.88
R&D exp. per employee (in th. euro)	2.39	3.29	3.54	3.13
Sales/empl: mean/median (in th. euro)	168.00/134.10	184.92/143.79	193.84/153.45	182.25/ 144.60
Share of innovative sales	6.44	14.31	11.72	10.77
Num. of employees: mean/median	128.72/34	138.64/36	136.36/38	134.57/36
% of firms with process innovation	66.61	41.45	41.12	49.73
% of firms with product innovation	33.88	34.87	45.23	37.99
% of firms with process innovation only	41.45	19.08	25.82	24.45
% of firms with process & product innov.	25.16	22.37	15.30	25.27

Table 2: Descriptive statistics for several groups of firms. Pooled sample (unbalanced panel and balanced panel).

UNBALANCED SAMPLE	**R&D firms**	**Innov. firms**	**High-tech ind.**	**Low-tech ind.**
Number of firms	4638	7728	4068	8925
% firms doing R&D	100	48.72	51.65	28.51
% firms doing innovation	81.16	100	66.83	56.25
R&D exp. over sales (%)	2.71	2.35	4.41	2.25
R&D exp. per employee (in th. euro)	3.75	3.99	5.54	5.27
Sales/empl: mean/median (in th. euro)	202.70/165.70	195.154.94	186.44/153.32	200.53/153.02
Share of innovative sales (%)	13.59	13.03	11.12	7.25
Num. of employees: mean/median	171.99/53	135.24/40	171.71/40	88.07/31
% of firms with process innovation	62.39	81.68	52.51	46.78
% of firms with product innovation	52.47	53.45	40.80	27.70
% of firms with process innovation only	26.75	46.55	25.97	28.45
% of firms with process & product innov.	35.64	35.13	26.54	18.33
BALANCED SAMPLE	**R&D firms**	**Innov. firms**	**High-tech ind.**	**Low-tech ind.**
Number of firms	890	1154	600	1,224
% firms doing R&D	100	59.62	68.45	39.18
% firms doing innovation	77.30	100	73.29	58.37
R&D exp. over sales (%)	1.88	2.04	2.30	1.48
R&D exp. per employee (in th. euro)	3.13	3.38	3.81	2.48
Sales/empl: mean/median (in th. euro)	188.32/ 153.27	178.17/ 145.17	173.07/143.46	186.75/145.25
Share of innovative sales	15.25	15.70	14.78	8.86
Num. of employees: mean/median	175.38/51	160.3917 /43	192.10/39	106.44/34
% of firms with process innovation	58.76	78.60	53.26	48.00
% of firms with product innovation	55.84	60.05	52.25	31.02
% of firms with process innovation only	37.30	38.65	32.22	20.65
% of firms with process & product innov.	21.46	39.95	21.04	27.35

Table 3: Employment growth on real sales growth and innovation dummies (non-structural model). All industries, unbalanced panel. Robust standard errors in parenthesis (also clustered in the pooled estimate).

Dependent variable: *employment growth rate (in percentage, l)*	ALL INDUSTRIES											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	OLS			OLS			OLS			OLS		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth ($g - \pi$)	0.25	0.01	0.000	0.17	0.01	0.000	0.26	0.02	0.000	0.23	0.01	0.000
Process inno only	-1.25	0.91	0.168	1.50	0.63	0.017	1.49	0.69	0.031	0.69	0.43	0.105
Product inno only	0.54	0.59	0.364	1.01	0.40	0.011	1.54	0.68	0.023	1.10	0.32	0.001
Process & product inno	1.49	0.76	0.049	1.94	0.48	0.000	2.84	0.63	0.000	2.13	0.36	0.000
α_0	2.01	0.56	0.000	0.30	0.26	0.126	1.26	0.44	0.002	1.05	0.24	0.000
test $g - \pi = 1$	2807.36		0.000	3094.24		0.000	2285.27		0.000	8112.53		0.000
N. obs	4290			4618			4040			12948		

Table 4: The effects of innovation on employment (basic model). All industries, unbalanced panel. Robust standard errors in parenthesis (also clustered in the pooled estimate).

Dependent variable: *empl. growth rate - real sales growth* in percentage, $l-(g_1-\pi)$	ALL INDUSTRIES											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	**OLS**			**OLS**			**OLS**			**OLS**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.97	0.02	0.000	0.96	0.01	0.000	0.96	0.03	0.000	0.96	0.01	0.000
α_0	-3.73	0.57	0.000	-5.88	0.42	0.000	3.00	0.55	0.000	-2.27	0.30	0.000
test $(g_2/(1+\pi))=1$	1.60		0.206	9.23		0.002	2.77		0.096	12.36		0.000
N. obs		4290			4618			4040			12948	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.04	0.09	0.000	0.95	0.04	0.000	1.10	0.07	0.000	0.99	0.10	0.000
α_0	-4.11	0.77	0.000	-5.80	0.59	0.000	1.80	0.80	0.012	-2.52	0.89	0.002
test $(g_2/(1+\pi))=1$	0.21		0.650	1.84		0.176	1.97		0.160	0.01		0.919
Test of overident. restr.	1.75		0.625	0.80		0.849	8.71		0.033	11.91		0.103
N. obs		4290			4618			4040			12948	

Note: R&D dummy, lagged R&D dummy, R&D intensity (R&D employment over total employment), and NEWPROD dummy used as instruments.

Table 4a: The effects of innovation on employment (basic model). High tech industries, unbalanced panel. Robust standard errors in parenthesis (also clustered in the pooled estimate).

Dependent variable: *empl. growth rate - real sales growth* in percentage, $l - (g_1 - \pi)$	HIGH TECH INDUSTRIES 1995-1997			1998-2000			2001-2003			1995-2003		
Estimation method	**OLS**			**OLS**			**OLS**			**OLS**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.02	0.04	0.000	0.96	0.02	0.000	0.87	0.05	0.000	0.95	0.02	0.000
α_0	-5.13	1.19	0.000	-4.63	0.78	0.000	4.10	1.21	0.000	-1.84	0.62	0.002
test $(g_2/(1+\pi)) = 1$	0.35		0.553	3.83		0.050	6.57		0.011	7.22		0.007
N. obs		1401			1394			1244			4039	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.97	0.13	0.000	0.88	0.06	0.000	1.09	0.15	0.000	0.78	0.15	0.000
α_0	-4.80	1.43	0.000	-3.40	1.19	0.002	1.81	1.95	0.177	0.04	1.78	0.491
test $(g_2/(1+\pi)) = 1$	0.06		0.808	4.00		0.046	0.34		0.560	2.13		0.145
Test of overident. restr.	4.08		0.253	2.21		0.530	7.67		0.053	9.36		0.228
N. obs		1401			1394			1244			4039	

Note: R&D dummy, lagged R&D dummy, R&D intensity (R&D employment over total employment), and NEWPROD dummy used as instruments.

Table 4b: The effects of innovation on employment (basic model). Low tech industries, unbalanced panel. Robust standard errors in parenthesis (also clustered in the pooled estimate).

Dependent variable: *empl. growth rate - real sales growth* in percentage, $l - (g_1 - \pi)$	**LOW TECH INDUSTRIES**											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	**OLS**			**OLS**			**OLS**			**OLS**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.94	0.03	0.000	0.95	0.02	0.000	1.00	0.03	0.000	0.97	0.01	0.000
α_0	-3.00	0.60	0.000	-6.56	0.49	0.000	2.58	0.54	0.000	-2.49	0.31	0.000
test $(g_2/(1+\pi)) = 1$	4.53		0.033	5.40		0.020	0.00		0.978	5.45		0.020
N. obs		2889			3224			2796			8909	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.13	0.12	0.000	1.01	0.05	0.000	1.11	0.08	0.000	1.07	0.12	0.000
α_0	-3.92	0.87	0.000	-7.05	0.65	0.000	1.82	0.75	0.008	-3.23	0.87	0.000
test $(g_2/(1+\pi)) = 1$	1.09		0.297	0.05		0.818	2.04		0.153	0.39		0.532
Test of overident. restr.	0.07		0.995	2.30		0.512	2.37		0.499	2.03		0.958
N. obs		2889			3224			2796			8909	

Note: R&D dummy, lagged R&D dummy, R&D intensity (R&D employment over total employment), and NEWPROD dummy used as instruments.

Table 5: The effects of innovation on employment; adding innovation dummies. All industries, unbalanced panel. Instrumental variables estimates. Robust standard errors in parenthesis (also clustered in the pooled estimate).

Dependent variable: *empl. growth rate - real sales growth* in percentage, $l - (g_1 - \pi)$	ALL INDUSTRIES											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.03	0.11	0.000	0.95	0.04	0.000	1.10	0.07	0.000	0.99	0.10	0.000
Process inno only	-1.52	1.26	0.229	0.27	0.76	0.723	-0.61	1.05	0.561	-0.84	0.92	0.362
α_0	-3.35	1.23	0.003	-5.84	0.69	0.000	1.95	0.87	0.013	-2.31	1.10	0.018
test $(g_2/(1+\pi)) = 1$	0.06		0.804	1.85		0.174	1.78		0.182	0.01		0.938
Test of overident. restr.	1.78		0.620	0.92		0.822	8.59		0.035	12.19		0.119
N. obs		4290			4618			4040			12948	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.07	0.20	0.000	0.91	0.07	0.000	1.15	0.10	0.000	0.96	0.11	0.000
Process inno only	-1.79	1.09	0.101	0.48	0.72	0.505	-0.81	1.04	0.437	-0.85	0.56	0.130
Process and product inno	-1.65	3.15	0.601	2.46	2.12	0.245	-1.53	1.45	0.294	0.66	1.99	0.740
α_0	-3.10	1.07	0.002	-5.92	0.69	0.000	1.89	0.86	0.014	-2.20	0.69	0.001
test $(g_2/(1+\pi)) = 1$	0.12		0.724	1.58		0.208	2.21		0.138	0.11		0.738
Test of overident. restr.	1.91		0.592	1.43		0.700	7.67		0.053	11.96		0.102
N. obs		4290			4618			4040			12948	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.03	0.11	0.000	0.94	0.04	0.000	1.09	0.08	0.000	0.98	0.10	0.000
Process and product inno	-1.49	1.31	0.254	0.47	0.85	0.578	-0.28	1.23	0.819	-0.87	1.12	0.438
Sales gr. due to new prod * process inno	-0.05	0.13	0.672	-0.05	0.08	0.506	-0.08	0.10	0.420	-0.03	0.10	0.792
α_0	-3.36	1.25	0.004	-5.83	0.70	0.000	2.00	0.89	0.012	-2.17	1.09	0.023
test $(g_2/(1+\pi)) = 1$	0.06		0.803	1.87		0.171	1.48		0.224	0.05		0.829
Test of overident. restr.	1.78		0.619	1.019		0.797	9.020		0.029	12.15		0.096
N. obs		4290			4618			4040			12948	

Note: R&D dummy, lagged R&D dummy, R&D intensity (R&D employment over total employment), and NEWPROD dummy used as instruments.

Table 6: The effects of innovation on employment; same specification of Harrison et al (2005), for comparison purposes. All industries, unbalanced panel. Instrumental variables estimates. Robust standard errors in parenthesis (also clustered in the pooled estimate).

Dependent variable: *empl. growth rate - real sales growth* in percentage, $l-(g_1-\pi)$	**ALL INDUSTRIES**											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Sales growth due to new prod (g_2)	0.97	0.10	0.000	0.94	0.04	0.000	1.06	0.07	0.000	1.00	0.10	0.000
Process inno only	-1.65	1.25	0.185	0.29	0.76	0.706	-0.68	1.05	0.513	-0.60	0.94	0.521
α_0	-3.16	1.21	0.005	-5.87	0.69	0.000	1.93	0.87	0.014	-2.61	1.13	0.010
test $g_2=1$	0.06		0.802	2.64		0.104	0.70		0.401	0.00		0.972
Test of overident. restr.	1.79		0.618	0.92		0.822	8.40		0.107	11.23		0.129
N. obs		4290			4618			4040			12948	

Table 7: The effects of innovation on employment: a comparison (1998-2000).

Dependent variable: *empl. growth rate - real sales growth* (in percentage, $l - g_1 - \pi$)	MCC data Italy	CIS data France	Germany	Spain	U.K.
Sales growth due to new prod (g_2)	0.94	0.98	1.01	1.02	0.98
	(0.04)	(0.06)	(0.07)	(0.04)	(0.05)
Process inno only	0.29	-1.31	-6.19	2.46	-3.85
	(0.76)	(1.57)	(2.92)	(1.78)	(1.87)
α_0	-5.87	-3.52	-6.95	-6.11	-4.69
	(0.69)	(0.78)	(1.86)	(0.90)	(0.88)
N. obs	4618	4631	1319	4548	2493

The first column is taken from the first specification of Table 6, while the others are from Harrison *et al.* (2005).

Table 8: The employment growth decomposition. All industries, unbalanced panel.

		ALL INDUSTRIES				
Employment growth decomposition	Year	Mean	Median	Std. Dev	Skewness	Kurtosis
	1997	5.052	0.000	17.954	-1.592	5.316
l Employment growth, in %	2000	2.537	0.000	11.502	-0.049	5.619
	2003	2.134	0.000	16.705	0.493	3.433
	Pooled	3.245	0.000	15.577	2.053	17.420
$\sum_j (\hat{\alpha_0} + \hat{\alpha_{0j}})\, Dind_j$	1997	-1.840	0.142	6.500	-0.280	1.078
Industry-specific productivity trend in production of	2000	-5.541	-6.014	2.643	1.373	2.886
old products	2003	1.242	2.526	5.265	-1.651	3.726
	Pooled	-2.187	-1.702	3.256	-0.811	3.704
$\hat{\alpha_1} d$	1997	-0.653	0.000	0.750	1.340	8.028
Change in employment due to the net effect of	2000	0.058	0.000	0.110	2.113	15.708
process innovation in the production of old products	2003	-0.111	0.000	0.235	0.878	10.931
	Pooled	-0.162	0.000	0.262	0.033	1.494
$[1 - 1(g_2 > 0)]\,(g_1 - \hat{\pi})$	1997	6.039	0.000	23.908	3.730	37.456
Change due to output growth of old products of those	2000	5.673	0.000	16.903	3.626	31.380
firms which did not introduce product innovation	2003	0.052	0.000	19.434	1.575	19.264
	Pooled	4.041	0.000	20.404	1.404	10.790
$1(g_2 > 0)\left(g_1 - \hat{\pi} + \hat{\beta}\frac{g_2}{1+\hat{\pi}}\right)$	1997	1.506	0.000	12.770	-0.518	6.730
Net contribution to employment growth of product innovation,	2000	2.347	0.000	11.454	-0.886	11.245
after adjustment for any substitution effect of old and new products	2003	0.950	0.000	15.990	-0.219	8.301
	Pooled	1.737	0.000	13.595	2.542	26.685
	1997	0.000	1.759	25.427	1.957	13.807
$\hat{u}$	2000	0.000	2.195	19.569	2.140	22.153
Residual component	2003	0.000	0.569	23.667	1.828	16.364
	Pooled	0.000	1.536	23.233	-0.496	8.209

This decomposition, $l = \sum_j (\hat{\alpha_0} + \hat{\alpha_{0j}})\, Dind_j + \hat{\alpha_1} d + [1 - 1(g_2 > 0)]\,(g_1 - \hat{\pi}) + 1(g_2 > 0)\left(g_1 - \hat{\pi} + \hat{\beta}\frac{g_2}{1+\hat{\pi}}\right) + \hat{u}$, is based on the coefficients reported in the first specification of Table 5. The skewness and the kurtosis are computed on the corresponding standardized distributions.

Table 9: The employment growth decomposition: a comparison (1998-2000).

Employment growth decomposition	MCC data	CIS data			
	Italy	France	Germany	Spain	U.K.
l Employment growth, in %	2.5	8.3	5.9	14.2	6.7
$\sum_j (\hat{\alpha_0} + \hat{\alpha_{0j}})\, Dind_j$ Industry-specific productivity trend in production of old products	-5.6	-1.9	-7.5	-5.7	-5.0
$\hat{\alpha_1} d$ Change in employment due to the net effect of process innovation in the production of old products	0.1	-0.1	-0.6	0.3	-0.4
$[1 - 1\,(g_2 > 0)]\,(g_1 - \hat{\pi})$ Change due to output growth of old products of those firms which did not introduce product innovation	5.7	4.8	6.0	12.2	8.3
$1\,(g_2 > 0)\left(g_1 - \hat{\pi} + \hat{\beta} g_2\right)$ Net contribution to employment growth of product innovation, after adjustment for any substitution effect of old and new products	2.4	5.5	8.0	7.4	3.9
N. obs	4618	4631	1319	4548	2493

This decomposition, $l = \sum_j (\hat{\alpha_0} + \hat{\alpha_{0j}})\, Dind_j + \hat{\alpha_1} d + [1 - 1\,(g_2 > 0)]\,(g_1 - \hat{\pi}) + 1\,(g_2 > 0)\left(g_1 - \hat{\pi} + \hat{\beta}\frac{g_2}{1+\hat{\pi}}\right) + \hat{u}$,is based on the coefficients reported in the first specification of Table 6. The figures for France, Germany, Spain and the U.K. are from Harrison *et al.* (2005).

Table A.1: Employment growth on real sales growth and innovation dummies. All industries, balanced panel.

Dependent variable: *employment growth rate (in percentage, l)*	**ALL INDUSTRIES**											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	OLS			OLS			OLS			OLS		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth ($g - \pi$)	0.27	0.03	0.000	0.22	0.05	0.000	0.27	0.03	0.000	0.25	0.02	0.000
Process inno only	-0.06	2.06	0.976	2.03	1.20	0.090	2.75	1.52	0.071	1.90	0.91	0.037
Product inno only	-1.18	1.78	0.507	1.61	0.99	0.104	2.86	2.15	0.183	0.78	0.88	0.377
Process & product inno	2.91	1.97	0.140	1.38	0.91	0.128	3.07	1.35	0.024	2.61	0.81	0.001
α_0	2.23	1.63	0.085	-0.13	0.67	0.422	-0.19	0.75	0.398	0.45	0.58	0.217
test $g - \pi = 1$	482.95		0.000	268.48		0.000	522.89		0.000	1369.51		0.000
N. obs	608			608			608			1824		

Table A.2: The effects of innovation on employment. All industries, balanced panel.

Dependent variable: *empl. growth rate - real sales growth* in percentage, $l-(g_1-\pi)$	**ALL INDUSTRIES**											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method		**OLS**			**OLS**			**OLS**			**OLS**	
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.09	0.05	0.000	0.94	0.02	0.000	0.96	0.05	0.000	0.98	0.02	0.000
α_0	-4.02	1.23	0.001	-5.54	0.81	0.000	5.34	1.05	0.000	-1.53	0.58	0.004
test $(g_2/(1+\pi))=1$	3.74		0.054	7.45		0.007	0.72		0.397	0.88		0.349
N. obs		608			608			608			1824	
Estimation method		**IV**			**IV**			**IV**			**IV**	
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.03	0.11	0.000	0.97	0.04	0.000	1.04	0.11	0.000	0.84	0.11	0.000
α_0	-3.64	1.31	0.003	-5.96	1.00	0.000	4.46	1.56	0.002	-0.11	1.26	0.466
test $(g_2/(1+\pi))=1$	0.07		0.795	0.56		0.454	0.15		0.695	2.08		0.149
Test of overident. restr.	0.11		0.947	1.74		0.419	4.68		0.096	2.92		0.819
N. obs		608			608			608			1824	

Note: R&D dummy, lagged R&D dummy, R&D intensity (R&D employment over total employment), and NEWPROD dummy used as instruments.

Table A.3: The effects of innovation on employment; adding innovation dummies. IV estimates. All industries, balanced panel.

Dependent variable: *empl. growth rate - real sales growth* in percentage, $l-(g_1-\pi)$	**ALL INDUSTRIES**											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.97	0.14	0.000	0.98	0.05	0.000	1.05	0.11	0.000	0.85	0.11	0.000
Process inno only	-2.92	2.43	0.228	1.47	1.56	0.347	2.68	2.74	0.328	-1.88	1.62	0.246
α_0	-2.18	1.93	0.129	-6.41	1.13	0.000	4.00	1.63	0.007	0.25	1.55	0.437
test $(g_2/(1+\pi))=1$	0.06		0.814	0.29		0.593	0.21		0.649	1.79		0.181
Test of overident. restr.	0.08		0.959	1.49		0.475	4.74		0.094	2.85		0.827
N. obs		608			608			608			1824	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.86	0.21	0.000	1.02	0.06	0.000	1.02	0.13	0.000	0.82	0.12	0.000
Process inno only	-2.19	2.43	0.367	1.13	1.59	0.478	2.91	2.77	0.294	-0.90	1.35	0.505
Process and product inno	4.30	4.15	0.300	-2.88	2.13	0.176	1.05	2.17	0.627	3.56	2.35	0.129
α_0	-2.87	1.97	0.072	-6.33	1.12	0.000	3.95	1.59	0.007	-0.60	1.13	0.297
test $(g_2/(1+\pi))=1$	0.48		0.487	0.09		0.767	0.03		0.857	2.14		0.143
Test of overident. restr.	0.02		0.989	1.18		0.555	4.17		0.124	2.80		0.834
N. obs		608			608			608			1824	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.97	0.14	0.000	0.98	0.05	0.000	1.05	0.12	0.000	0.84	0.11	0.000
Process and product inno	-2.99	2.49	0.231	2.06	1.74	0.236	4.88	3.06	0.111	-2.10	1.89	0.266
Sales gr. due to new prod * process inno	0.13	0.15	0.387	-0.10	0.05	0.075	-0.34	0.15	0.026	0.04	0.12	0.741
α_0	-2.17	1.95	0.132	-6.48	1.17	0.000	3.93	1.71	0.011	0.39	1.53	0.401
test $(g_2/(1+\pi))=1$	0.05		0.819	0.25		0.614	0.19		0.660	2.21		0.137
Test of overident. restr.	0.08		0.959	1.59		0.452	5.82		0.055	2.83		0.830
N. obs		608			608			608			1824	

Note: R&D dummy, lagged R&D dummy, R&D intensity (R&D employment over total employment), and NEWPROD dummy used as instruments.

Table A.4: The effects of innovation on employment; same specification of Harrison et al (2005), for comparison purposes. All industries, balanced panel. Instrumental variables estimates. Robust standard errors in parenthesis (also clustered in the pooled estimate).

Dependent variable: *empl. growth rate - real sales growth* (in percentage, $l - g_1 - \pi$)	ALL INDUSTRIES											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Sales growth due to new prod (g_2)	0.92	0.13	0.000	0.97	0.04	0.000	1.02	0.11	0.000	0.86	0.11	0.000
Process inno only	-2.93	2.42	0.226	1.57	1.56	0.315	2.59	2.74	0.343	-1.57	1.63	0.337
α_0	-2.03	1.91	0.144	-6.38	1.11	0.000	3.85	1.63	0.009	-0.10	1.59	0.475
test $g_2 = 1$	0.43		0.513	0.58		0.445	0.04		0.847	1.63		0.202
Test of overident. restr.	0.17		0.919	1.25		0.535	4.45		0.108	2.83		0.830
N. obs		608			608			608			1824	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Sales growth due to new prod (g_2)	0.80	0.19	0.000	1.00	0.06	0.000	1.00	0.13	0.000	0.83	0.12	0.000
Process inno only	-2.15	2.43	0.377	1.26	1.59	0.429	2.80	2.77	0.312	-0.74	1.36	0.586
Process and product inno	4.57	4.06	0.260	-2.67	2.11	0.206	0.94	2.18	0.664	3.07	2.39	0.199
α_0	-2.78	1.96	0.079	-6.30	1.10	0.000	3.80	1.60	0.009	-0.82	1.15	0.237
test $g_2 = 1$	1.05		0.306	0.00		0.947	0.00		0.983	1.88		0.170
Test of overident. restr.	0.06		0.971	0.99		0.608	3.89		0.143	2.83		0.830
N. obs		608			608			608			1824	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Sales growth due to new prod (g_2)	0.92	0.13	0.000	0.97	0.05	0.000	1.03	0.12	0.000	0.84	0.11	0.000
Process and product inno	-3.01	2.49	0.227	2.18	1.74	0.211	4.93	3.06	0.107	-1.70	1.92	0.375
Sales gr. due to new prod * process inno	0.15	0.14	0.297	-0.10	0.05	0.070	-0.36	0.15	0.017	0.01	0.12	0.925
α_0	-2.02	1.93	0.148	-6.46	1.16	0.000	3.75	1.72	0.015	0.03	1.57	0.491
test $g_2 = 1$	0.42		0.518	0.51		0.475	0.05		0.826	2.02		0.155
Test of overident. restr.	0.17		0.919	1.34		0.513	5.547		0.062	2.88		0.824
N. obs		608			608			608			1824	

Table A.5: The effects of innovation on employment: a comparison (1998-2000).

Dependent variable: *empl. growth rate - real sales growth* (in percentage, $l - g_1 - \pi$)	MCC data Italy	CIS data France	Germany	Spain	U.K.
Sales growth due to new prod (g_2)	0.97	0.98	1.01	1.02	0.98
	(0.04)	(0.06)	(0.07)	(0.04)	(0.05)
Process inno only	1.57	-1.31	-6.19	2.46	-3.85
	(1.56)	(1.57)	(2.92)	(1.78)	(1.87)
α_0	-6.38	-3.52	-6.95	-6.11	-4.69
	(1.11)	(0.78)	(1.86)	(0.90)	(0.88)
N. obs	608	4631	1319	4548	2493

The first column is taken from the first specification of Table A.4, while the others are from Harrison *et al.* (2005).

Table A.6: The employment growth decomposition. All industries, balanced panel.

		ALL INDUSTRIES				
Employment growth decomposition	Year	Mean	Median	Std. Dev	Skewness	Kurtosis
	1997	5.617	0.000	15.783	-1.130	6.103
l Employment growth, in %	2000	2.495	0.000	9.325	0.152	4.699
	2003	0.942	0.000	14.390	0.453	3.440
	Pooled	3.018	0.000	13.588	2.008	19.283
$\sum_j (\hat{\alpha_0} + \hat{\alpha_{0j}})\, Dind_j$	1997	0.034	2.029	6.059	-0.347	1.121
Industry-specific productivity trend in production of	2000	-5.962	-6.062	2.926	1.574	3.477
old products	2003	2.776	4.273	6.812	1.928	4.718
	Pooled	-1.451	-1.530	3.319	0.423	4.170
$\hat{\alpha_1} d$	1997	-1.214	0.000	1.444	1.361	8.545
Change in employment due to the net effect of	2000	0.300	0.000	0.619	1.688	10.385
process innovation in the production of old products	2003	0.397	0.000	0.935	0.621	8.556
	Pooled	-0.066	0.000	0.114	0.063	1.500
$[1 - 1\,(g_2 > 0)]\,(g_1 - \hat{\pi})$	1997	5.766	0.000	20.470	3.495	34.209
Change due to output growth of old products of those	2000	4.456	0.000	12.096	2.572	17.073
firms which did not introduce product innovation	2003	-1.442	0.000	15.894	-0.715	11.695
	Pooled	2.927	0.000	16.798	1.265	10.141
$1\,(g_2 > 0)\left(g_1 - \hat{\pi} + \hat{\beta}\frac{g_2}{1+\hat{\pi}}\right)$	1997	1.031	0.000	13.127	-0.352	7.250
Net contribution to employment growth of product innovation,	2000	3.700	0.000	11.380	-0.084	5.396
after adjustment for any substitution effect of old and new products	2003	-0.789	0.000	14.566	0.113	6.834
	Pooled	1.609	0.000	13.462	1.398	20.241
	1997	0.000	1.239	22.184	2.140	14.588
$\hat{u}$	2000	0.000	1.081	14.672	2.102	21.401
Residual component	2003	0.000	-0.534	19.736	1.508	19.752
	Pooled	0.000	0.695	19.605	-0.119	7.819

This decomposition, $l = \sum_j (\hat{\alpha_0} + \hat{\alpha_{0j}})\, Dind_j + \hat{\alpha_1} d + [1 - 1\,(g_2 > 0)]\,(g_1 - \hat{\pi}) + 1\,(g_2 > 0)\left(g_1 - \hat{\pi} + \hat{\beta}\frac{g_2}{1+\hat{\pi}}\right) + \hat{u}$,is based on the coefficients reported in the first specification of Table A.3. The skewness and the kurtosis are computed on the corresponding standardized distributions.

Table A.7: The employment growth decomposition: a comparison (1998-2000).

Employment growth decomposition	MCC data Italy	CIS data France	Germany	Spain	U.K.
l Employment growth, in %	3.0	8.3	5.9	14.2	6.7
$\sum_j (\hat{\alpha_0} - \hat{\alpha_{0j}})\, Dind_j$ Industry-specific productivity trend in production of old products	-1.5	-1.9	-7.5	-5.7	-5.0
$\hat{\alpha_1} d$ Change in employment due to the net effect of process innovation in the production of old products	-0.1	-0.1	-0.6	0.3	-0.4
$[1 - 1\,(g_2 > 0)]\,(g_1 - \hat{\pi})$ Change due to output growth of old products of those firms which did not introduce product innovation	2.9	4.8	6.0	12.2	8.3
$1\,(g_2 > 0)\left(g_1 - \hat{\pi} + \hat{\beta} g_2\right)$ Net contribution to employment growth of product innovation, after adjustment for any substitution effect of old and new products	1.6	5.5	8.0	7.4	3.9
N. obs	608	4631	1319	4548	2493

This decomposition, $l = \sum_j (\hat{\alpha_0} + \hat{\alpha_{0j}})\, Dind_j + \hat{\alpha_1} d + [1 - 1\,(g_2 > 0)]\,(g_1 - \hat{\pi}) + 1\,(g_2 > 0)\,(g_1 - \hat{\pi} + \hat{\beta} g_2) + \hat{u}$, is based on the coefficients reported in the first specification of Table A.3.

Table A.8: The effects of innovation on employment; adding innovation dummies. High-tech industries, unbalanced panel. Instrumental variables estimates. Robust standard errors in parenthesis (also clustered in the pooled estimate)
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Dependent variable: *empl. growth rate - real sales growth* in percentage, $l-(g_1-\pi)$	HIGH-TECH INDUSTRIES											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.92	0.15	0.000	0.88	0.06	0.000	1.08	0.16	0.000	0.78	0.15	0.000
Process inno only	-2.21	2.27	0.330	-2.01	1.75	0.251	-1.41	2.42	0.561	-3.50	2.00	0.080
α_0	-3.55	2.25	0.058	-2.90	1.46	0.024	2.14	2.13	0.158	0.98	2.25	0.332
test $(g_2/(1+\pi))=1$	0.25		0.617	3.80		0.051	0.25		0.617	2.12		0.146
Test of overident. restr.	3.84		0.279	2.29		0.515	7.53		0.057	9.84		0.198
N. obs		1401			1394			1244			4039	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.85	0.23	0.000	0.83	0.10	0.000	1.20	0.21	0.000	0.74	0.16	0.000
Process inno only	-1.42	1.92	0.462	-1.94	1.74	0.265	-2.10	2.39	0.379	-2.60	1.34	0.053
Process and product inno	3.28	4.13	0.428	3.19	2.91	0.273	-3.50	2.50	0.161	3.53	2.78	0.204
α_0	-4.34	1.87	0.010	-2.84	1.51	0.030	2.05	2.11	0.166	0.25	1.54	0.435
test $(g_2/(1+\pi))=1$	0.42		0.516	2.99		0.084	0.90		0.343	2.57		0.109
Test of overident. restr.	4.00		0.262	2.34		0.505	6.35		0.096	9.67		0.208
N. obs		1401			1394			1244			4039	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	0.93	0.15	0.000	0.88	0.06	0.000	1.04	0.16	0.000	0.77	0.14	0.000
Process and product inno	-2.24	2.30	0.331	-2.19	1.89	0.247	-0.47	3.00	0.877	-3.98	2.22	0.073
Sales gr. due to new prod * process inno	0.15	0.20	0.441	0.06	0.12	0.593	-0.18	0.19	0.365	0.14	0.16	0.363
α_0	-3.57	2.24	0.056	-2.91	1.45	0.023	2.54	2.14	0.118	1.17	2.15	0.294
test $(g_2/(1+\pi))=1$	0.24		0.624	3.81		0.051	0.07		0.790	2.63		0.105
Test of overident. restr.	3.85		0.279	2.29		0.514	8.26		0.041	9.32		0.231
N. obs		1401			1394			1244			4039	

Table A.9: The effects of innovation on employment; adding innovation dummies. Low-tech industries, unbalanced panel. Instrumental variables estimates. Robust standard errors in parenthesis (also clustered in the pooled estimate)

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Dependent variable: *empl. growth rate - real sales growth* in percentage, $l-(g_1-\pi)$	LOW-TECH INDUSTRIES											
	1995-1997			**1998-2000**			**2001-2003**			**1995-2003**		
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.12	0.13	0.000	1.01	0.05	0.000	1.11	0.08	0.000	1.07	0.12	0.000
Process inno only	-0.91	1.46	0.532	1.07	0.80	0.180	-0.33	1.12	0.769	-0.20	0.92	0.827
α_0	-3.47	1.40	0.006	-7.28	0.73	0.000	1.90	0.83	0.011	-3.17	1.07	0.002
test $(g_2/(1+\pi))=1$	0.82		0.366	0.03		0.854	1.96		0.162	0.40		0.526
Test of overident. restr.	0.06		0.996	2.61		0.455	2.35		0.503	2.02		0.959
N. obs		2889			3224			2796			8909	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.37	0.28	0.000	1.04	0.09	0.000	1.12	0.11	0.000	1.08	0.14	0.000
Process inno only	-1.37	1.34	0.308	1.16	0.77	0.132	-0.34	1.13	0.765	-0.47	0.59	0.432
Process and product inno	-6.85	4.36	0.116	-0.47	2.91	0.871	-0.25	1.67	0.881	-1.17	2.60	0.652
α_0	-3.14	1.32	0.008	-7.50	0.71	0.000	1.86	0.81	0.011	-2.95	0.67	0.000
test $(g_2/(1+\pi))=1$	1.71		0.191	0.20		0.657	1.25		0.264	0.37		0.543
Test of overident. restr.	0.04		0.998	2.51		0.474	2.25		0.523	2.03		0.958
N. obs		2889			3224			2796			8909	
Estimation method	**IV**			**IV**			**IV**			**IV**		
	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value	Coeff.	S.E.	P-value
Real sales growth due to new prod $(g_2/(1+\pi))$	1.13	0.14	0.000	1.01	0.05	0.000	1.10	0.08	0.000	1.07	0.12	0.000
Process and product inno	-0.78	1.54	0.613	1.63	0.90	0.069	-0.30	1.28	0.812	0.06	1.19	0.961
Sales gr. due to new prod * process inno	-0.18	0.16	0.256	-0.13	0.09	0.186	-0.01	0.10	0.935	-0.11	0.13	0.408
α_0	-3.55	1.45	0.007	-7.27	0.75	0.000	1.92	0.85	0.012	-3.15	1.10	0.002
test $(g_2/(1+\pi))=1$	0.85		0.357	0.01		0.915	1.75		0.186	0.35		0.555
Test of overident. restr.	0.06		0.996	3.06		0.382	2.38		0.497	2.11		0.953
N. obs		2889			3224			2796			8909	