

# Low-wage Competition, Credit Constraints and Innovation Strategies of Italian Firms

Ines Buono \*

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## Abstract

How did low-wage competition and financial constraints shape the innovation choices of Italian firms? According to the theory, firms may increase their expenditure in innovation ('escape competition effect') or reduce it ('Schumpeterian effect') in response to competition pressures. On the contrary, credit availability should always favour innovation adoption. I analyze these issues empirically with a data set that includes firm-level indicator of competition from low-wage countries and balance-sheet as well as self-declared measures of credit constraints, and that allows me to decompose firm innovation choices into product versus process innovation. I find that 'Schumpeterian effect' is rejected as firms innovate when competition becomes tougher. In particular, firms that face competition only from low-wage countries, tend to introduce product - as opposed to process - innovation, the effect being driven by *specialized* and *high-tech* sectors only. Credit availability, instead, fosters process -but not product- innovation.

*Keywords: Low-wage competition, Product and process innovation, Financial constraints.*

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\*Correspondance: Banca d'Italia, via Nazionale 91, 00184, Rome, Italy. E-mail: ines.buono@bancaditalia.it. The views expressed are those of the author and do not necessarily reflect those of the Bank of Italy. I am grateful to Antonio Accetturo, Matteo Bugamelli, Paula Bustos, Gino Gancia, Francesca Lotti and Massimo Sbracia for useful comments.

# 1 Introduction

In the last few years the acceleration of imports from low-wage countries created a new competitive environment and new challenges for Northern firms. Their response and its consequences in terms of employment and industrial structure is central to the recent policy debate.

According to the recent theoretical literature on trade and firm heterogeneity, a higher degree of openness increases country's productivity via the reallocation of resources from the less to the more productive firms within each sector.<sup>1</sup> These models postulate that productivity increases even without any response within each firm, whose production technology is maintained constant in the new environment. The industrial organization literature, instead, considers the increase in competition as one of the main forces behind the innovation choices of firm. Competition may foster or reduce the incentive to innovate within each firm: if the 'Schumpeterian effect' prevails, then a firm decreases its spending in innovation since the higher competition reduces the return on R&D investment. Conversely, if the 'escape-competition effect' prevails, then firms' incentives to innovate increase as innovation raises the probability of surviving. Moreover, the effect of market structure on innovation incentives depends crucially on firms' financial constraints. For example, Schumpeter suggested that innovation is easier in oligopolistic markets where the profits from market power provide firms with the internal financial resources necessary to invest in innovative activity.<sup>2</sup>

In this paper I explore how competition pressures from low-wage countries and credit constraints shaped the innovation choices of Italian firms in the last decade. First, I take advantage of a specific feature of this kind of competition, typically characterized by low-quality product, to investigate whether Italian firms reacted through a product or a process innovation strategy. While the latter consists in the introduction of organizational or new production technologies aimed at reducing the unit-cost of production, the former consists in exploiting the love-of-variety of consumers providing them with new products, either in terms of quality upgrading

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<sup>1</sup>See Melitz (2003) for the monopolistic competition case and Finicelli, Pagano and Sbracia (2012) for the perfect competition Ricardian case. In the former productivity at firm level is enhanced also by a scale effect, that is not present in the latter due to the constant return to scale assumption of Ricardian models. In this paper, instead, the focus is on determinants of country productivity other than just market-share reallocation and scale effects.

<sup>2</sup>See Schumpeter (1942).

of existing ones, either in terms of a new variant. Second, I use a direct measure of exposition to low-cost countries competition within each firm. Empirical studies that analyze the effect of low-wage countries' competition on firms, usually measure it with the domestic share of imports from low-wage countries (over total imports). Differently from them, by using the information of competition pressure at the firm level from survey data, I can control for sector unobserved heterogeneity as well as sector time trends, exploiting the fact that firms in the same sector may be subject to different competition pressures. Third, I allow for the role of financial constraints in the innovation choices of a firm. The empirical literature has recently emphasized the importance of this factor for the probability of firms to carry product and/or process innovation. In a recent paper, Becker and Egger (2007) report that the majority of firms in the Ifo survey conducted in Germany, declares that 'internal' and 'external funding' (rather than 'long amortization period' or 'imperfect cooperation with public institution') are the main impediments they face. Also in Italy, access to bank credit is a widely debated issue, especially given the small average size of Italian firms.

To sum up, in this work I tackle the following questions. Does the increase of competition from low-wage countries foster innovation by Italian firms? Which strategy, between product or process innovation, is chosen by firms? Do financial constraints play a relevant role too?

To answer these questions, I use three waves (1998, 2001, 2004) of Capitalia-Mediocredito surveys on Italian firms. Each survey collects information over the previous three years, therefore I use information for 1995-1997, 1998-2000 and 2001-2003 respectively. This data set contains information on the specific kind of innovation pursued by firms (product, process or both), the origin of their main competitors (low-wage vs high-wage countries),<sup>3</sup> and balance-sheet as well as self-declared measures of financial constraints to which each firm is subject.

A clear-cut picture of firms' innovation attitude emerges from the analysis, results being robust to the of many firm characteristics indicated by literature (such as productivity, age, riskiness). First, the Schumpeterian effect is strongly rejected since firms that face higher competition tend to innovate with higher probability. A caveat applies, though. I do not observe firms that have exited the market in the years I consider. If exited firms are the ones that do not innovate, then results are upward biased.

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<sup>3</sup>In the rest of the paper competition from low-wage countries may be referred as Southern competition, while that from high-wage countries may be referred as Northern competition.

Second, the specific component of competition (low-wage versus high-wage) is strongly related to the kind of innovation (product or process) firms adopt. Firms that declare to have major competitors in low-wage countries are 14% more likely to introduce product innovation and only 4.6% more likely to introduce process innovation than other firms. When I introduce firm level control variables and adopt a multinomial estimation strategy, I find that competition from low-wage countries has no effect on process innovation alone, but significantly influences product innovation. On the other hand, Northern competition fosters both product and process innovation. Thus, results indicate that firms adopt a ‘defensive strategy’ specific to the competition they face.

Third, previous findings are relevant only for *specialized* and *high-tech* sectors in Pavitt classification. Conversely, firms in *traditional* and *scale-intensive* sectors do not react to low-wage competition. These first three findings suggest a tendency of Italian firms to relocate toward higher-quality segment and, probably, to use the defensive skill-upgrading innovation.<sup>4</sup>

Fourth, differently from low-wage competition, credit availability, measured with firm tangible assets, a proxy for collateral, is a key factor for the introduction of process innovation, while it is irrelevant for product innovation. The reason may be that process innovation is easily monitorable and it is usually accomplished through the adoption of new machineries, whose value may add to their collateral. On the contrary, product innovation and its outcomes are less tangible. In addition, the absence of a significant bank-firm relationships behind product innovation may signal that firms account on internal resources only to adopt this strategy. Further research, however, is necessary to analyze whether this potential behaviour is voluntary or not and whether the way credit availability is measured is crucial for previous results.

As I mentioned, I do not observe firms that exited the market in this data set. Moreover, the data set has a scarce longitudinal variation.<sup>5</sup> However I can be sure that the firms I observe did survive in the market. This may create an upward bias in previous results. Suppose, for example, that firms that did not introduce product innovation in those years exited the market, while those that introduced it survived. By observing only survivors, I can attribute

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<sup>4</sup>Thoenig and Verdier (2003) propose a model in which Northern firms escape Southern competition by improving the skill content of their products.

<sup>5</sup>There is rotation in firms that are interviewed and only one third of the firms are kept in two subsequent surveys. This does not allow to know if a firm that exited the survey also exited the market.

the virtuous response (adopt the right strategy to the external shock) to all firms, while it actually was chosen only by better firms.

While I cannot properly control for it, this potential bias is in line with the consensus that Italian firms innovate less than their European counterparts and that competition from low-wage countries erode a great portion of domestic market which was previously served by Italian firms. In the last section, I thus explore how firms' sales and profits are correlated to innovation choices and low-wage competition in the same period. Preliminary results suggest that firms more exposed to low-cost countries' competition have lower contemporaneous sales, but this effect is attenuated by the adoption of product innovation. Moreover, I find that product innovation *per se* is not correlated with sales. In other words, the adoption of product innovation seems to relax the negative effects of low-wage competition on domestic sales. This finding leaves an open question: why is it the case that Italian firms did not react more along this "winning" strategy? Why only few firms started to produce new products? I turn to explore if financial constraints had a role in this dynamics, potentially preventing the virtuous response of firms. I analyze this for at least two reasons. The first is that the small size of Italian firms and its consequent lack of internal resources may have been a strong disadvantage in that situation. The second is that access to credit has been indicated as essential for a winning response in times of fast changes in the market environment.

Preliminary results suggest that firms more exposed to low-wage competition adopted product innovation with higher probability when their collateral was high. However the effect is statistically insignificant in most of the specifications. That is, financial constraints did not prevent firms from pursuing the right defensive strategy once hit by competition from low-wage countries.

The paper is organized as follows. The next section discusses the relevant literature. In Section 3, I describe the data, report the main results and the robustness checks. In Section 4, I discuss preliminary results on the interaction of financial constraints and low-wage competition. Section 5 concludes.

## 2 Literature

This paper is related with three different strands of literature. The first analyzes the effects of the exposure to low-cost countries' imports on plants outcomes other than technology adoption. Bernard, Redding and Schott (2006) explore the role of international trade in the reallocation of U.S. manufacturing within and across industries from 1977 to 1997. They find that plant survival and growth are negatively associated with industry exposure to low-wage competition, so that manufacturing activity is reallocated towards more capital-intensive plants. Bugamelli, Fabiani and Sette (2010) analyze the Italian case and find that greater exposure to competition from China diminished the pace of firms' output price increase. This suggests that Italian firms carry out a cost-reduction strategy. Moreover they find that reaction was stronger in traditional sectors, where firms compete mostly on price.

The second strand of literature relates to firms' technology adoption as a consequence of changes in market conditions. The empirical literature on this topic is still quite scarce, but it is increasing thanks to the availability of micro surveys aimed at monitoring firms and their choices. Bustos (2011) analyzes the technology adoption of Argentinean firms after the reduction of Brazilian tariffs induced by the formation of Mercosur. She finds that, as market dimension increases (she looks at the export market), the probability to adopt technology increases at firm level. Lelarge and Nefussi (2008) investigate whether Southern competition, measured as the share of import penetration by low-cost countries, affects French firms R&D expenditure. They find that both the level and the decision to conduct R&D are affected by Southern competition. Fernandez and Paunov (2009) find that import competition had a positive impact on Chilean plant-level product quality upgrading. Teshima (2008) explores to extent to which Mexican firms adopt technology (measured with R&D intensity) as trade liberalization is introduced. Finally Bloom, Draca and Van Reenen (2011) find that exposure to Chinese competition significantly increases the propensity of firms to adopt Information and Communcation Technology (computer, hardware and software products). The data set they use, which consists in a long panel that contains the information on european firms exiting and entering the market, allows them to analyze also the 'extensive margin' response of firms. In this respect they find that exposure to trade with China increases the probability of firm exits and reduce employment growth expecially for less IT intensive firms. All previous studies

measure the increase in competition either by considering specific episodes of liberalization (especially when less-developed countries are analyzed) either by measuring low-wage competition with the share of low-cost import penetration in more-developed countries. Differently from them, I consider a firm level measure of exposure to low-wage competition, which allows me to fully control for sector characteristics.

The third strand of literature investigates the impact of credit constraints on firm innovation choices. Herrera and Minetti (2006) use this same data set and explore the role of information (on firms) detained by firm's main bank, which they proxy with the duration of credit relationship, on firm innovation choices. They find that firms with longer credit relationship introduce product innovation with higher probability. Instead, results on process innovation are not statistically significant. Benfratello, Schiantarelli and Sembenelli (2008) investigate the role of Italian local banking development on firms' innovative activity. They find that banking development, which they measure with the per-capita number of bank branches in Italian provinces, affects the probability of adopting process innovation only. They argue that a possible explanation for the asymmetric result on process vs product innovation is that the latter is a riskier kind of innovation and Italian banks may be more reluctant to finance it, being less evaluable than the former one. Alessandrini, Presbitero and Zazzaro (2007) build on this discussion and analyze the same research question measuring credit availability with the distance of bank branches from their head-quarter. Finally, Savignac (2006) analyzes French data and use a firms' self-declared measure of credit constraints to analyze if credit availability has a role in the innovation choices of firms. She finds a positive answer. The novelty in this work with respect to this literature is to jointly analyze the role of low-wage competition and credit constraints for firms innovation choices.

### **3 The effect of low-cost countries competition**

In this section I provide the main results of the paper. I first describe the data and the way in which the main variables are constructed. I then discuss the econometric specification and the main results. Finally I show that results are robust to the introduction of control variables, to different specification and to alternative measures of financial constraints.

### 3.1 Data

Main data come from the surveys on Italian firms conducted by Mediocredito-Capitalia and are integrated with CERVED firm-level balance-sheet data.<sup>6</sup> Capitalia surveys are conducted every three years on a representative sample of small and medium Italian manufacturing firms. The majority of the questions are asked with respect to the previous three years. The survey I use, collected in 1998, 2001 and 2004 reports information on 1995-1997, 1998-2000 and 2001-2003 for more than 4000 firms. Only few questions allow for a specific answer in any of the previous 3 years, while the majority require a unique answer for the previous three years as a whole. For example firms are asked about the composition of their employment for each of the three previous years, thus this variable has a consistent panel dimension. Unfortunately questions on innovation choices and credit constraints have not this additional time dimension. Moreover, between consecutive surveys, only one third of the sample is kept while the remaining part is replaced by other firms. This sampling scheme allows for randomness criteria but does not return a substantial panel structure. In fact the researcher observes only few firms across all the surveys and does not know if firms exited from the survey are also exited from the market.<sup>7</sup> Thus in what follows I will structure my analysis considering the data as a pooled cross-section. After merging this with CERVED balance-sheet data, I obtain a pooled cross-section of slightly less than 11,000 observations.<sup>8</sup>

In what follows I describe the way I measure the main variables in this analysis (innovation adoption (process and product), low-cost competition pressure and credit constraints). Later I briefly describe other relevant variables, while in next sub-section I focus on variables I use as controls in the variety of robustness checks I conduct.

The measures of innovation, provided by the Capitalia survey, consists in a series of indicators aimed at capturing product and/or process innovation choice by firms. Industrial organization literature has recognized the importance of distinguishing between product and process innovation. The reason is that these two types of innovations are used for different purposes.

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<sup>6</sup>I also use other two sources, TRAINS and Guiso et al.(2004) data on Italian bank branches in 1936 to built some robustness checks, as I describe later.

<sup>7</sup>Only 648 firms are observable for the three consecutive surveys I use.

<sup>8</sup>Depending on the variables used in each regression I can count on different number of observations since both Capitalia and CERVED data are not complete for all the firms in all the years.



	1995	1998	2001
Process innovation (alone)	43.4	26.5	19.1
Product innovation (alone)	6.9	9.0	16.2
Both process and product innovation	25.0	17.7	26.9
No innovation	24.6	46.8	37.8
Number of Firms	4460	4678	4289

Table 1: Percentage of firms that choose each innovation strategy by survey.

Process innovations lower the overall cost of production while product innovations, consisting in improvement of the quality of a product or in the creation of a new variety, increase the price buyers are willing to pay. I use three different measures according to the answers given by firms to the following question: "In the past three years did the firm realize product innovations, process innovations, organizational innovations related to product innovation, organizational innovations related to process innovations?". The dependent variables are thus indicators that equal 1 if a firm has engaged in: (a) product or related organizational innovation ('product'), (b) process or related organizational innovation ('process'), (c) product or process or related organizational innovation ('innovation').

In table 1 I report, for each survey, the percentage of firms that adopted process, product, both kind of innovation or nothing. While the adoption of process innovation becomes less frequent as time goes by, the adoption of product innovation turns out to be more relevant, as a higher number of firms choose it.

I measure firm exposure to competition from low-wage countries using a question which asks: "Where are localized your main competitors?" The answer (which can be multiple) allows for the following geographical areas: Italy, other European countries, other industrialized countries, China and other less industrialized countries.<sup>9 10</sup> The main indicator variable I use

<sup>9</sup>The possible answers change in the three surveys becoming more detailed in the last one in which a firm can choose among Italy, 15 EU countries, new EU countries, China, other Asian countries, US and Canada, other industrialized countries (that is in any other group except developing countries). I obtain an homogeneous variable aggregating the answers in the last survey.

<sup>10</sup>This variable should be relevant for domestic competition and not for competition in foreigner markets. In fact in the survey there is also a question in which the firm may indicate the location of its exports. Moreover, I

	1995	1998	2001
Southern	2.7	3.1	12.1
UE	25.3	24.6	29.0
Northern	10.9	10.4	6.6
Number of Firms	4460	4678	4289

Table 2: Percentage of geographical component of competition in each survey.

(LDC) equals 1 if the firm declares that among its main competitors there are firms from least developed countries. This variable captures the intensity of low-wage competition for each firm in the sample. Notice that the exclusion group consists in all those firms that declare to have competitors in Italy and/or other EU countries and/or other industrialized countries. Since firms may declare to have their main competitors in one or more geographical areas, this first indicator does not distinguish among firms that have competitors located in low-wage and high-wage countries from firms whose competitors are only in low-wage ones. I thus consider other measures. First, I build a stricter indicator which selects those firms that are subject *only* to low-wage competition (as well as domestic one) ("pure LDC").<sup>11</sup> Here the excluded group includes firms that may have both low-wage and high-wage competition. Second, I construct an indicator which discriminate among those firms that have international competition (ROW) and those that have only local competitors (ITA). Third, I consider low-wage and high-wage competition separately (LDC, DC).

Table 2 shows the percentage of firms in our sample that declare to have their main competitors in one of the groups (less developed countries, other European Union countries and other developed countries). The year reported refer to the first year in each survey. What is striking is the huge increase in firms that declare to have their main competitors among Southern countries (from 2.7% to 12.1%). This shows how well this variable captures the process of increase in Southern imports which here is considered as a fundamental shock the the Italian consider reasonable that the main competitors Italian firms recognize refer to competition in the market where the firms sell most of their products, that is Italy (notably the export is a small percentage of total sales of a firm).

<sup>11</sup>All firms declare to have their main competitors in Italy and they may or not choose other geographical areas.

market structure in last decade. Previous studies have used the sectorial exposition to Southern competition.<sup>12</sup> This indicator has not been used yet as a measure of competition pressure, as far as I know. Here I propose to use it since, differently from sector-specific measures of low-cost countries' competition, this variable is firm specific. This allows me to control for sector-specific unobserved heterogeneity, as well as sector trends or macro-shock in the analysis.

The second important determinant which is crucial in firms' innovation decision are financial constraints. Literature on firm and bank relations has used many different measures to detect the existence of financial constraints in firms. We can divide them into four different groups: balance-sheet measures to capture firm collateral, survey self-declared measures, measures related to specific bank-firm relationship and firm size.

In the first group, financial constraints are measured by considering firm balance-sheet figures that indicate how safely a bank would lend to a firm. The main balance-sheet proxies for financially constrained firms are "coverage ratio of interest payment" and the "asset tangibility". The first (usually calculated as financial expenses over financial expenses plus profits) is aimed at measuring the ability of a firm to repay its debt. The second, more common, is the ratio between fixed and total assets and it has been considered the main measure of a firm collateral. The availability of collateral, which can be expropriated in case of default, reduces the cost of firm's bankrupt for bankers, thus increasing the firm's probability to receive external finance. Once size and other dimension indicators, which may be captured by tangible collateral, are accounted for, this variable should affect the innovation propensity of firms only through its effect on the access to external (banking) finance.

The second group refers to self-declared financial constraints measures, which have been used only recently in the literature. With this same data, but with different purposes, Angelini and Generale (2008) and Caggese and Cuñat (2008) build self-declared financial constraints dummies using the answers to the following questions in the survey: (a) did the firm desire more credit at the given interest rate?; (b) would have the firm paid higher interest rate in order to obtain credit?; (c) did the firm ask more credit without obtaining it?. Seignac (2006) uses a similar survey for French enterprises and obtains a self-declared financial constraints measure which resembles the previous one.

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<sup>12</sup>See Bugamelli and Rosolia (2006) or Bloom, Draca and Van Reenen (2011).

The third group regards those measures aimed at capturing more closely the characteristics of the firm-bank relation. In particular the most common are either measures that capture bank efficiency by itself (number of bank branches per province, Guiso et al.(2004)) either variables that describe the relation of each firm with its main banks (age of the relation, number of banks the firm uses, share of loans in the main bank, firm age).

The last common proxy for credit access is firm size. It is well-known that small firms have more difficulties in getting additional fundings. The reasons may be seen as trasversal to the ones enumerated before. Smaller firms, in fact, tend to have smaller tangible assets, to have less networks and to be less transparent, thus negatively affecting their access to bank credit.<sup>13</sup>

The main proxy for credit availability I use is given by "tangible asset" (which I refer to as "collateral" from now on). In checking for the robustness of the results, I show that all the main findings hold using either the self-declared measure or bank branches per capita by Guiso et al.(2004).

## 3.2 Main results

I run the following probit, here expressed in terms of a latent variable model:

$$Inn_{i,s,t}^* = \beta_0 + \beta_1 Comp_{i,s,t} + \beta_2 CA_{i,s,t-1} + \beta_3 X_{i,s,t} + \delta_t + \delta_s + \epsilon_{i,s,t}, Inn_{i,s,t} = 1[Inn_{i,s,t}^* > 0]$$

where

- *Inn* is one of three possible dichotomous innovation indicators and *Inn*<sup>\*</sup> is the correspondent latent variable;
- *Comp* can be each of the different measures of competition pressure by firm: "LDC" is low-wage competition; "LDC pure" is the stricter measure of low-wage competition; "ROW" is international competition, either low-wage, either high-wage or both; finally "DC" is high-wage competition;
- *CA*, bank credit availability, is measured with collateral;

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<sup>13</sup>Firm size is also important for innovation itself. Pagano and Schivardi (2004) find that larger size fosters productivity growth because it allows italian firms to take advantage of all the increasing returns associated with R&D.

variable	continuous/discrete	mean	standard deviation	min	max
LDC	D	0.06	0.23	0	1
DC	D	0.25	0.43	0	1
LDC pure	D	0.02	0.15	0	1
ROW	D	0.31	0.46	0	1
collateral	C	0.29	0.16	0	0.99
size	D	0.7	0.45	0	1
exporter	D	0.69	0.45	0	1
mkt share	C	0.006	0.04	0	1
productivity (log)	C	3.72	0.51	-1.37	7.34
sales (log)	C	8.88	1.31	3.9	15.4
age	C	23.9	18	1	146
group	D	0.25	0.43	0	1
RD	C	0.006	0.08	0	1
corporation	D	0.93	0.23	0	1
ISO9000	D	0.4	0.49	0	1
equity	C	54.5	29.9	0	100

Table 3: Descriptive statistics of variables in regressions.

- $X$  contains a series of firm-level characteristics that act like controls. Among them, some controls are used in all the regressions: region fixed effects, an indicator variable for the firm being an exporter, and the market share of a firm in its sector.<sup>14</sup>
- $\delta_t$  are time fixed effects;  $\delta_s$  are ATECO 2-digit sector fixed effects.
- $\epsilon_{i,s,t}$  is a continuously standard normally distributed variable independent of the set of regressors.

Table 3 reports the descriptive statistics of variables used in this section, as well as controls which are introduced later on.

Columns (1) to (3) of Table 4 show results from the basic regression, while in columns from (4) to (6) the size of firm (a dummy for firms with more than 20 employees) is included as control.<sup>15</sup>

<sup>14</sup>This is the share of a firm sales over the overall sales of its 2-digit ATECO sector.

<sup>15</sup>I report directly marginal effects evaluated at the mean of each independent variable.

	innova	product	process	innova	product	process
	(1)	(2)	(3)	(4)	(5)	(6)
collateral	0.182 (6.13)***	0.08 (2.75)***	0.252 (8.17)***	0.15 (5.02)***	0.049 (1.68)*	0.219 (7.05)***
size				0.106 (9.64)***	0.096 (8.84)***	0.111 (9.70)***
LDC	0.084 (4.13)***	0.14 (6.71)***	0.046 (2.13)**	0.082 (4.04)***	0.138 (6.63)***	0.043 (2.00)**
exporter	0.141 (12.77)***	0.165 (15.40)***	0.106 (9.24)***	0.122 (10.92)***	0.15 (13.74)***	0.087 (7.43)***
mkt share	0.298 -1.33	0.531 (2.71)***	0.613 (2.57)**	0.083 -0.4	0.354 (1.90)*	0.385 (1.76)*
year 2001	-0.227 (19.06)***	-0.049 (4.28)***	-0.243 (20.15)***	-0.215 (17.89)***	-0.037 (3.22)***	-0.231 (18.95)***
year 2004	-0.147 (11.81)***	0.104 (8.81)***	-0.234 (18.81)***	-0.151 (12.07)***	0.102 (8.65)***	-0.238 (19.10)***
ATECO 2-digit FE	YES	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	10874	10874	10874	10874	10874	10874

\*\*\*:significant at the 1% level; \*\*:significant at the 5% level; \*: significant at the 10% level.

Marginal effects are reported. Constant and dummies marginal effects are omitted.

Robust z test in parenthesis.

Table 4: Results from basic regressions. Marginal effects with a probit model.

Using size as control is important for two reasons. The first is that according to the findings of the industrial organization literature, the kind of innovation (process or product) introduced by firms may crucially depend on firm size since the latter yields different incentives in adopting the two kinds of innovation. Cohen and Klepper (1996) find and rationalize the fact that the share of innovative effort devoted to process innovation is greater among larger firms. In fact, larger firms may spread the cost of introducing a novel production technology on a great quantity of output. The second reason is that size is a good proxy for the firm collateral and for its access to bank credit, as explained before. Thus controlling for size should eliminate the bias in the collateral coefficient. I also consider an indicator for the exporter status to pick up a series of differences among firms regarding their productivities, technology intensities, adoption of skilled workers. In fact, as literature has shown for many countries including Italy, exporters are "superstar" firms which share - as opposed to non-exporters - the pool of previous virtuous characteristics. Finally I include a market share indicator which selects how big a firm is (in terms of sales) compared to other firms in its sector. The purpose here is to complement the measure of firm size, allowing for the effect of size even in sectors with different structure (a firm may be small in the sample, but big compared to the other firms in its sector). Finally sectors fixed effects pick-up all the other relevant factors affecting the propensity to innovate like 'demand-pull', 'technological push' factors and appropriability conditions, which differ across sectors.<sup>16</sup>

I find that both collateral and exposure to low-wage competition are main predictors of the allocation of innovative activities between product and process innovation. In the first column, for example, I find that firms with low-wage competition are 8.4% more likely to innovate than firms with main competitors in Italy and/or in other European or industrialized countries. This probability is much higher when we consider product innovation (14%) and get smaller for process innovation (4.6%). Financial constraints also explain the innovation attitude of firms but are much more relevant for process innovation. For a firm with a share of tangible assets higher than 1 percentage point, the probability to innovate increases by 8% for product and by 25.2% for process. When I introduce size results are qualitatively the same but financial constraints become even less important for product innovation. How I was expecting, collateral

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<sup>16</sup>See Cohen and Levin (1989) for an optimal survey.

and firm size are strongly correlated. Big firms are the ones that introduce more innovation, especially process innovation as literature emphasizes. Finally, exporters and firms with high market shares innovate more than other firms.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	innova	product	process	innova	product	process	innova	product	process
collateral	0.148 (4.98)***	0.046 -1.55	0.217 (7.00)***	0.148 (4.98)***	0.046 -1.55	0.217 (7.00)***	0.15 (5.03)***	0.051 (1.73)*	0.219 (7.05)***
size	0.098 (8.85)***	0.086 (7.87)***	0.104 (9.06)***	0.098 (8.85)***	0.087 (7.91)***	0.104 (9.04)***	0.107 (9.70)***	0.097 (8.96)***	0.111 (9.73)***
ROW	0.12 (10.92)***	0.135 (12.63)***	0.097 (8.44)***						
LDC				0.115 (5.71)***	0.183 (8.61)***	0.076 (3.51)***			
DC				0.118 (10.16)***	0.126 (11.01)***	0.101 (8.26)***			
LDC pure							0.031 -1.01	0.082 (2.65)***	-0.035 -1.07
exporter	0.096 (8.37)***	0.124 (10.96)***	0.065 (5.40)***	0.096 (8.37)***	0.125 (11.01)***	0.064 (5.37)***	0.125 (11.16)***	0.153 (14.09)***	0.088 (7.59)***
mkt share	0.008 -0.04	0.274 -1.52	0.315 -1.47	0.007 -0.04	0.265 -1.46	0.32 -1.5	0.115 -0.55	0.404 (2.19)**	0.398 (1.83)*
year 2001	-0.219 (18.15)***	-0.041 (3.48)***	-0.234 (19.19)***	-0.219 (18.15)***	-0.041 (3.49)***	-0.234 (19.18)***	-0.215 (17.85)***	-0.037 (3.17)***	-0.23 (18.91)***
year 2004	-0.152 (12.26)***	0.107 (9.09)***	-0.242 (19.52)***	-0.152 (12.14)***	0.102 (8.63)***	-0.24 (19.17)***	-0.145 (11.66)***	0.111 (9.42)***	-0.233 (18.76)***
ATECO 2-digit FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	10874	10874	10874	10874	10874	10874	10874	10874	10874

\*\*\*:significant at the 1% level; \*\*:significant at the 5% level; \*: significant at the 10% level.  
 Marginal effects are reported. Constant and dummies marginal effects are omitted.  
 Robust z test in parenthesis.

Table 5: Marginal effects with a probit model. Northern and Southern competition.

In Table 5 I report regressions, all including the firm size indicator, considering international vs local competition (ROW) (columns (1) to (2)), Southern and Northern competition (LDC and DC) (columns (4) to (6)) and the stricter measure of Southern competition (LDC pure) (columns (7) to(9)). Results confirms that financial constraints are not a determinant of product innovation, being instead highly important for process innovation. Product innovation, alone or combined with process innovation, responds to Southern competition, instead. This result holds even when Northern competition is accounted for. Finally, results in last columns helps not to confound the effect of mixed kind of competition from the Southern one. Firms whose competition comes *only* from low-wage countries invest in product innovation with a probability that is 8.2% higher than in other firms. Process innovation, instead, is not adopted by these firms, nor alone nor jointly with product innovation.



### 3.3 Endogeneity issues

Should competition measure be endogeneous, previous results would be misleading. Even if I use a firm-level measure of low-wage competition, which allows to take sector unobserved heterogeneity into account, I cannot exclude the possibility that endogeneity may play a role. For instance, low-wage countries may export more in those sectors that typically innovate less. In this case, those firms that innovate less would be more exposed to competition from low-wage countries.

To tackle this issue, I run a Rivers-Vuong (1988) test for endogeneity.<sup>17</sup> To run this test, I use two alternatives instruments for the low-wage competition indicator. First, I consider the share of imports from China and other emerging market in each 2-digit ATECO sector for the relevant years. Second, I take advantage of the fact that China, the main low-wage country exporting to Europe in last decade, entered in WTO in 2001. Around 2001 China had to reduce its tariffs, while countries in WTO had to adopt the same tariffs they set against other partners to China. Even if this event happened somewhat gradually over time, and actually started before 2001, we can consider tariffs set from EU (and thus Italy) toward China as a good exogenous proxy for the low-wage competition pressure in European markets.

Data on tariffs and import shares from low-wage countries come from TRAINS- WTO. In Figure 1 I plot the average European tariffs against China and the average Chinese tariffs against EU for all the sample years. Chinese tariffs decreased significantly in last decade becoming quite comparable with EU tariffs. These, in turn, increased in 1995-1997, but in 1998 they decreased drastically. Thus, since my analysis considers years from 1995 to 2004, I can count on a great amount of variability of tariffs.

I perform a River-Vuong test for each of these instruments, both including and excluding sector and regional dummies from the first stage. I also tried a specification in which I consider both EU tariffs against China and Chinese tariffs against EU as instruments. In all these cases I can never reject the hypothesis that the coefficient of the residual in the second step equals zero. Therefore, there is no evidence of endogeneity of the low-wage competition indicator.

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<sup>17</sup>This test consists in estimating the possible endogenous variables on instruments, save the residuals and run a probit model inserting the residual of the first step. The z-test on the estimated residual is a test for endogeneity of the previously instrumented variable.

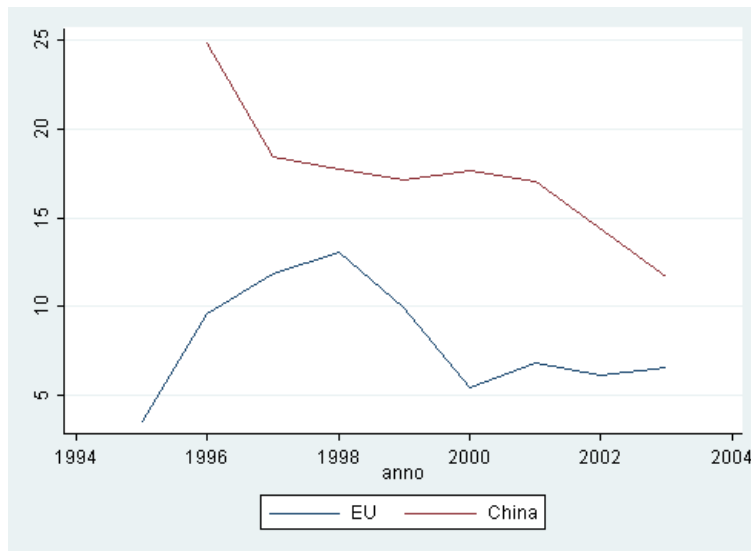


Figure 1: Average tariffs (in %) set from China against EU (red line) and from EU against China (blu line).

As a further check, I adopt a IV procedure in which I instrument LDC with the sector-time varying EU tariffs against China.<sup>18</sup> Results using a linear probability model strengthen the previous findings: low-wage competition causes product innovation but does not explain process innovation, while collateral remains highly significant for process innovation only.<sup>19</sup>

### 3.4 Adding controls

In this sub-section, I consider all those control variables that the literature identifies as the important determinants of firm innovation strategy and show that previous results are basically unchanged.

I follow Herrera and Minetti (2006) and consider other factors that are predicted to influence innovation through firms' access to external credit: transparency of the entrepreneur's actions, innovation efficiency, and firm overall riskiness.

First, transparency is positive related with firm age, since older firms have a larger history. To capture this I introduce firms' age and its square. Transparency is also related to the firm

<sup>18</sup>I consider tariffs at the 2-digit ATECO and I averaged them for the three years to which each survey refers.

<sup>19</sup>In what follows I treat the measure of import penetration as exogenous. In ongoing analysis I take care of the possible endogeneity of import penetration using other instrument variables. While coefficients vary in their magnitudes, results strongly support the main findings here discussed.

size, which I control for introducing the log of total firm sales, in addition to the usual size dummy. I also include a dummy for a firm being a corporation, since these have information dues that make them more transparent. Finally I include the share of equity of the principal owner, since according to the literature, large shareholders are less exposed to a free-rider problem in producing information of the firm (Ongena and Smith, 2001). Second, as a measure of efficiency and return advantage of the new technology I introduce an indicator for a firm that has obtained a ISO9000 certification from the European Union. For those firms in fact the efficiency in the production process and/or in the quality of their product is certified. I also introduce R&D spending to capture firm level input in the process of innovation (higher input should conduce to higher innovation efficiency). Other factors which the literature consider as important in the return advantage of a new technology concern the firm dimension, its market size and its age, already included in the control set. Finally the riskiness of the firm is approximated by its productivity (measured as value added per worker) and by a dummy for firms belonging to a group, since the head of a group may provide guarantees for its subsidiary companies.

Table 6 reports results with all the control variables for low-wage competition, its stricter measure and low-wage versus high-wage competition. As before firms that are more subject to low-wage competition innovate more, expecially in terms of product innovation (12.7% vs 4.3%). The availability of high collateral in the balance-sheet is important to get credit for innovation process but does not play any role for innovation product activity even when all the controls are inserted in the regression. Exporters, bigger firms in terms of employment and sales, older firms and those that received an ISO9000 certification are the ones that innovate more. Interestingly the effect of market share turns now to be negative and highly significant only for process and overall innovation. This may be the results of the introduction of total sales at the firm level. It reveals that the size of the firm and not its size with respect to its sector is important for innovation. It may also indicate that within each sector, those firms that already serve a big portion of the market, have less incentive to innovate. In any case, this exercise reveals that the main variables are not capturing other omitted firm characteristics, since results are unchanged with or without the control set.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	innova	product	process	innova	product	process	innova	product	process
collateral	0.144 (4.70)***	0.036 -1.23 (6.65)***	0.21 (6.65)***	0.145 (4.74)***	0.036 -1.2 (6.67)***	0.211 (6.67)***	0.144 (4.70)***	0.037 -1.27 (6.65)***	0.21 (6.65)***
size	0.052 (4.01)***	0.051 (4.14)***	0.057 (4.25)***	0.049 (3.83)***	0.049 (3.92)***	0.055 (4.12)***	0.052 (4.05)***	0.052 (4.16)***	0.057 (4.27)***
LDC	0.082 (3.93)***	0.127 (6.11)***	0.043 (1.96)**	0.11 (5.34)***	0.168 (7.91)***	0.07 (3.20)***			
DC				0.104 (8.64)***	0.113 (9.80)***	0.084 (6.70)***			
LDC pure							0.041 -1.33 (2.64)***	0.082 (2.64)***	-0.021 -0.63
exporter	0.096 (8.28)***	0.129 (11.63)***	0.061 (5.07)***	0.075 (6.36)***	0.109 (9.50)***	0.045 (3.61)***	0.099 (8.49)***	0.132 (11.91)***	0.063 (5.21)***
mkt share	-0.865 (3.00)***	-0.44 (1.94)*	-0.622 (2.31)**	-0.852 (3.00)***	-0.417 (1.88)*	-0.609 (2.29)**	-0.836 (2.81)***	-0.422 (1.86)*	-0.607 (2.23)**
productivity	0.009 -0.86	-0.014 -1.27	0.016 -1.38	0.009 -0.78	-0.015 -1.38	0.015 -1.33	0.009 -0.77	-0.015 -1.42	0.015 -1.28
sales	0.036 (5.44)***	0.029 (4.83)***	0.035 (5.28)***	0.033 (5.05)***	0.026 (4.32)***	0.033 (4.93)***	0.036 (5.38)***	0.029 (4.90)***	0.035 (5.25)***
age	0.001 (2.60)***	0.001 (2.98)***	0.001 (1.86)*	0.001 (2.24)**	0.001 (2.51)**	0 -1.55	0.001 (2.82)***	0.001 (3.34)***	0.001 (2.00)**
age squared	0 (2.51)**	0 (3.10)***	0 -1.61	0 (2.14)**	0 (2.62)***	0 -1.3	0 (2.73)***	0 (3.46)***	0 (1.76)*
group	-0.002 -0.17	0.006 -0.48	0.011 -0.8	-0.006 -0.46	0.001 -0.09	0.008 -0.57	-0.002 -0.13	0.007 -0.53	0.012 -0.82
RD	0.153 (2.52)**	0.114 (1.93)*	0.142 (2.13)**	0.147 (2.41)**	0.11 (1.84)*	0.138 (2.06)**	0.156 (2.56)**	0.124 (2.10)**	0.145 (2.17)**
corporation	0.052 (1.96)*	0.04 -1.51	0.016 -0.56	0.05 (1.89)*	0.037 -1.41	0.014 -0.5	0.053 (1.98)**	0.04 -1.53	0.016 -0.59
ISO9000	0.072 (6.55)***	0.037 (3.47)***	0.072 (6.32)***	0.067 (6.08)***	0.031 (2.90)***	0.068 (5.95)***	0.072 (6.49)***	0.036 (3.38)***	0.072 (6.27)***
equity	0 (2.37)**	0.001 (3.75)***	0 -1.15	0 (2.19)**	0.001 (3.55)***	0 -1.01	0 (2.47)**	0.001 (3.92)***	0 -1.23
year 2001	-0.226 (18.31)***	-0.041 (3.51)***	-0.24 (19.37)***	-0.229 (18.47)***	-0.043 (3.71)***	-0.243 (19.52)***	-0.226 (18.27)***	-0.04 (3.48)***	-0.24 (19.33)***
year 2004	-0.188 (14.30)***	0.077 (6.42)***	-0.272 (20.97)***	-0.186 (14.12)***	0.081 (6.69)***	-0.271 (20.84)***	-0.183 (13.95)***	0.084 (7.05)***	-0.268 (20.67)***
ATECO 2-digit FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	10796	10796	10796	10796	10796	10796	10796	10796	10796

\*\*\*:significant at the 1% level; \*\*:significant at the 5% level; \*: significant at the 10% level.

Robust t test are the ones reported. Constant and dummies coefficient are not reported.

Table 6: Marginal effects with a probit model. Northern and Southern competition. All controls included.

### 3.5 Multinomial logit

In all previous regressions product and process innovation have been treated as independent choices. The way dependent variables are constructed mixes together firms that adopt one of this innovation alone with firms that adopt both of them. To get further intuition I handle innovation in an alternative way. I build an indicator of innovation that is ‘0’ if a firm does not innovate, ‘1’ if a firm adopts process innovation alone, ‘2’ if it adopts product innovation alone and ‘3’ if it adopts both innovations together. I then run a multinomial logit that relates the three possible choices of firms against the same excluded category (not taking innovation at all). This methodology allows for comparable results among any couple of alternatives.

Results are reported in Table 7. Coefficients are the odds (in logs) of the category reported the column with respect to the excluded one. For example in the first three columns LDC coefficients reveal that the odds between introducing process innovation and not introducing any kind of innovation is 0.96, but it is not significant.<sup>20</sup> On the contrary, the odds for product innovation and joint innovations are positive and highly significant when firms have low-wage competition.

I separately report in Table 8 the odds of LDC for each couple of categories in the first regression. Each number is the odds of the category reported in the row over that reported in the column for firms with LDC equal to 1. For example firms under LDC competition pressure have bigger probabilities to introduce product innovation over process innovation (odds= 1.58\*\*\*), while introducing product or both kind of innovation is not distinguishable. Columns (4) to (6) of table 10 show the asymmetric response of innovation choices for what concerns DC vs LDC competition. Firms that face low-wage competition do not respond innovating process, while firms with Northern competition pressure have also the incentive to introduce new process, along with new products. Finally, last three columns, show that using ‘LDC pure’ measure strengthen the results. In this case the only significant action firms undertake is doing product

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<sup>20</sup>The odds or relative risk is the ratio of two probabilities: in this case is the ratio, *ceteris paribus*, of the probability for a firm to introduce process innovation and the probability of not introducing any innovation. Since the coefficients are expressed in logs, one needs to compute  $\exp(-0.0473) = 0.96$ . An odds lower than 1 indicates that the choice at the numerator is less likely than the one at the denominator, with respect to the variable we are considering. In this case, firms with Southern competition (LDC=1) have less probability to choose process innovation than not to introduce innovation. However this coefficient is not significant.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	only proc	only prod	both	only proc	only prod	both	only proc	only prod	both
collateral	0.776*** (0.157)	-0.21 (0.23)	0.853*** (0.174)	0.779*** (0.157)	-0.211 (0.23)	0.860*** (0.175)	0.774*** (0.157)	-0.21 (0.23)	0.855*** (0.174)
size	0.156** (0.066)	0.103 (0.092)	0.434*** (0.077)	0.152** (0.066)	0.095 (0.092)	0.421*** (0.077)	0.157** (0.066)	0.105 (0.092)	0.436*** (0.077)
LDC	-0.0473 (0.133)	0.419*** (0.132)	0.580*** (0.113)	0.0168 (0.134)	0.551*** (0.134)	0.818*** (0.114)			
DC				0.283*** (0.066)	0.481*** (0.085)	0.723*** (0.067)			
LDC pure							-0.182 (0.2)	0.373** (0.183)	0.227 (0.172)
exporter	0.150*** (0.058)	0.651*** (0.090)	0.738*** (0.070)	0.101* (0.059)	0.562*** (0.092)	0.591*** (0.071)	0.152*** (0.058)	0.662*** (0.090)	0.756*** (0.070)
mkt share	-4.097** (1.920)	-6.614*** (2.488)	-3.792** (1.487)	-4.103** (1.926)	-6.568*** (2.485)	-3.674** (1.442)	-4.132** (1.951)	-6.600*** (2.492)	-3.718** (1.490)
productivity	0.110* (0.057)	-0.0327 (0.078)	-0.00463 (0.063)	0.109* (0.057)	-0.0361 (0.078)	-0.0127 (0.063)	0.109* (0.057)	-0.0349 (0.078)	-0.0142 (0.062)
sales	0.121*** (0.036)	0.128*** (0.047)	0.220*** (0.036)	0.116*** (0.036)	0.116** (0.047)	0.201*** (0.036)	0.120*** (0.036)	0.129*** (0.047)	0.220*** (0.036)
age	0.00208 (0.001)	0.00891** (0.004)	0.00487*** (0.001)	0.00179 (0.001)	0.00823** (0.004)	0.00410*** (0.001)	0.00213 (0.001)	0.00903** (0.004)	0.00535*** (0.001)
age squared	-9.32E-07 (0.000)	-0.0000598 (0.000)	-2.41e-06*** (0.000)	-7.9E-07 (0.000)	-0.0000578 (0.000)	-2.01e-06** (0.000)	-9.6E-07 (0.000)	-0.0000582 (0.000)	-2.66e-06*** (0.000)
group	-0.0353 (0.071)	-0.12 (0.098)	0.0636 (0.074)	-0.0464 (0.071)	-0.14 (0.099)	0.0343 (0.075)	-0.034 (0.071)	-0.116 (0.099)	0.0671 (0.074)
RD	0.601 (0.377)	0.491 (0.478)	0.978*** (0.354)	0.59 (0.377)	0.467 (0.478)	0.952*** (0.358)	0.603 (0.377)	0.509 (0.478)	1.007*** (0.355)
corporation	0.179 (0.134)	0.603** (0.235)	0.134 (0.155)	0.175 (0.134)	0.595** (0.235)	0.11 (0.155)	0.181 (0.134)	0.604** (0.235)	0.143 (0.156)
ISO9000	0.332*** (0.058)	0.216*** (0.078)	0.377*** (0.062)	0.323*** (0.058)	0.198** (0.079)	0.340*** (0.062)	0.332*** (0.058)	0.214*** (0.078)	0.371*** (0.062)
equity	0.000348 (0.000)	0.00295** (0.000)	0.00309*** (0.000)	0.000308 (0.001)	0.00285** (0.001)	0.00289*** (0.000)	0.000349 (0.000)	0.00302** (0.001)	0.00324*** (0.000)
year 2001	-1.153*** (0.061)	-0.395*** (0.096)	-0.947*** (0.070)	-1.164*** (0.061)	-0.413*** (0.097)	-0.971*** (0.070)	-1.153*** (0.061)	-0.394*** (0.097)	-0.944*** (0.070)
year 2004	-1.373*** (0.068)	0.302*** (0.094)	-0.636*** (0.072)	-1.372*** (0.068)	0.306*** (0.094)	-0.622*** (0.072)	-1.370*** (0.068)	0.317*** (0.094)	-0.592*** (0.072)
ATECO 2-digit FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	10798	10798	10798	10798	10798	10798	10798	10798	10798
ll	-13050	-13050	-13050	-12989	-12989	-12989	-13065	-13065	-13065

\*\*\*:significant at the 1% level; \*\*:significant at the 5% level; \*: significant at the 10% level.  
Robust standard errors in parenthesis. Constant and dummies coefficient are not reported.

Table 7: Multinomial specification. All controls included.

innovation only (not even both kind of innovation).

For what concerns the collateral, previous findings are confirmed. In particular the absence of financial constraints is effective in enhancing process innovation. However it is irrelevant for product innovation.

Thus Italian firms did not rival with low-cost products trying to shrink their production costs. Instead, they tried to conquer that part of the market where consumers demand was more shifted toward ‘altered’ (e.g. higher quality) or brand-new goods. Results may thus suggest a ‘flight to quality’ of Italian firms. The fact collateral played no role in product innovation may signal that firms did not implement this innovation recurring to bank credit. It seems like if firms, independently from their size and from their access to credit, managed to adopt product innovation as a winning strategy against the acceleration of import penetration from low-wage countries.

	no innovation	only PROC	only PROD	both
only PROC	0.96 (0.723)		0.63 (0.002)***	0.54 (0.000)***
only PROD	1.52 (0.001)***	1.58 (0.002)***		0.85 (0.203)
both	1.79 (0.000)***	1.86 (0.000)***	1.17 (0.203)	

Table 8: Odds for columns (1) to (3) of multinomial regression in Table 7

In Table 9 I investigate how results change across sectors. I show only the relevant coefficients for multinomial regressions in which I separate the effect of Southern and Northern competition for groups of sectors, classified according to the Pavitt classification. This classification is quite important in this context since it categorizes sectors along trajectories of technological change according to sources of technology (in-house or external) and appropriability regime. The first group (Pavitt (1)) includes *traditional sectors* such as textiles and agriculture which rely on sources of innovation external to the firm and are suppliers dominated. The second group (Pavitt (2)) contains *scale-intensive sectors* whose sources of innovation, either internal or external, are characterized by a medium-level appropriability degree within firms.

The third group (Pavitt (3)) includes *specialized suppliers sectors*. These are usually smaller, more specialized firms producing technology that can be sold to other firms, e.g. specialized machinery production and high-tech instruments. These sectors are characterized by a high level of appropriability due to the tacit nature of the knowledge. Finally the last group (Pavitt (4)) contains the *high-technology sectors*, firms which strongly rely on R&D (mainly pharmaceuticals and electronics). An important task of firms in this sector is to develop new products or processes; in fact, they usually have a high degree of appropriability from patents, secrecy, and tacit know-how.

Results from a multinomial specification reveals interesting patterns that allow to distinguish the response of product and process innovation to Northern and Southern competition in each Pavitt group. Process innovation is not correlated to Southern competition in any of the Pavitt group. Instead, Northern competition explains process innovation but only for *specialized* and *high-tech sectors*. On the other hand, Southern competition is considerably correlated to product innovation, exactly in *specialized* and *high-tech sectors*. Finally firms in these sectors are the more reactive ones in introducing product innovation to Northern competition too.<sup>21</sup>

These results complement those found in Bugamelli, Fabiani, Sette (2010). Using the IN-VIND data set on Italian firms they find that the competitive pressure exerted by Chinese competition induced Italian firms to decrease prices. This result holds only for firms in *low-tech* sectors (which are defined as *traditional*, *scale-intensive* and *specialized* ones).<sup>22</sup> They focus their analysis on firms' price strategy and not directly on their innovation choices. However, since process innovation is related to price-competition while product innovation is related to quality-competition, we can compare results in this paper with their findings. The result in Bugamelli and all. (2010) suggests that firms in *low-tech* sectors possibly react with process innovation to Chinese competition. Results in this paper, instead, suggest that *high-tech* and *specialized* firms react with product innovation to low-wage (and so Chinese) competition.<sup>23</sup>

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<sup>21</sup>Coefficients of the other control variables are not reported since they do not disclose any other relevant information with respect to previous findings.

<sup>22</sup>Basically they use the Pavitt classification to distinguish between high-tech (Pavitt 4) and low-tech (Pavitt 1, 2 and 3) sectors.

<sup>23</sup>The fact I do not find results for process innovation in *low-tech* sectors may depend from many reasons. First, we use different data set. Second, the connection between price-setting and process innovation is only indicative. The results together may suggest that firms in *low-tech* sectors may have reduced prices even without



Taken together these findings indicate that sector characteristics highlighted in Pavitt classification (sources of technology and appropriability regime) indeed shape the way firms react to changes in the competitive arena.<sup>24</sup> Firms in *high-tech* sectors relied on their comparative advantage in the introduction and exploitation of product innovation. On the other hand, firms in *low-tech* sectors were not able to take their chance to fly to quality.<sup>25</sup>

Differences in firms response and in the role of bank-credit suggest that sectors need specific policies when competition becomes tougher. First, traditional sectors should receive more incentives to adopt product innovation. These may come either strengthening the remuneration of an innovation effort (higher appropriability degree) either easing its cost for the firm. Second, the bank-firm cooperation should be incentivated in the case of product innovation. Results, in fact, suggest that bank-firm relation is important for process innovation, but insignificant for product innovation. This asymmetry signals that banks are more willing to finance less risk and more observable innovation, and once they do it, they use their usual devices (they link their concessions to collateral) to overcome moral hazard problems. However banks do not help firms once product innovation, less evaluable, is at stake.<sup>26</sup>

### 3.6 Robustness checks on financial constraints

As discussed before, the main balance-sheet measure of financial constraints may capture other characteristics than credit access. I thus follow the literature and use a measure of credit constraints which is self-declared by firms. I build this measure as in previous papers that use these data (Caggese and Cuñat (2008), Angelini and Generale (2008)). Those firms which introducing any process innovation (by reducing existing inefficiencies or by exploiting more intensively internal resources, for instance). Finally we use a different set of controls since we look at different outcomes.

<sup>24</sup>Notice that since regressions include sector fixed effects, we can safely conclude that distinction in Pavitt classification and not other sector unobserved characteristics are what matters here.

<sup>25</sup>However it worths saying that *low-tech* firms slightly introduced jointly product and process innovation in response to low-wage competition, how the third column suggests.

<sup>26</sup>Moreover, when I introduce the level of total firm investment, collateral turns out to be non-significant also for process innovation. This would suggest that banks consider as collateral the value of the tangible innovation a firm introduces. Since process innovation comes along with the acquisition of new machineries, bank-firm relation is significant for process innovation. This finding could indicate that banks finance investment, not innovation. More work, however, should be done to assess either this result either its intuition.

	(1)	(2)	(3)
	only proc	only prod	both
collateral	0.77*** (0.156)	-0.20 (0.230)	0.85*** (0.175)
size	0.15** (0.066)	0.09 (0.092)	0.42*** (0.077)
LDC*pavitt (1)	-0.21 (0.187)	0.24 (0.187)	0.68*** (0.156)
LDC*pavitt (2)	-0.006 (0.375)	0.25 (0.411)	0.70** (0.207)
LDC*pavitt (3)	0.35 (0.248)	1.07*** (0.242)	1.12*** (0.212)
LDC*pavitt (4)	0.71 (0.541)	1.22*** (0.506)	1.21*** (0.477)
DC*pavitt (1)	0.16 (0.100)	0.23* (0.131)	0.64*** (0.099)
DC*pavitt (2)	0.19 (0.142)	0.38** (0.185)	0.69*** (0.138)
DC*pavitt (3)	0.39*** (0.106)	0.72*** (0.130)	0.76*** (0.106)
DC*pavitt (4)	0.81*** (0.235)	0.96*** (0.272)	1.21*** (0.226)
ATECO 2-digit FE	YES	YES	YES
Regional FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	10798	10798	10798
ll	-12976	-12976	-12976

\*\*\* 1% level; \*\* 5% level; \* 10% level.

Robust standard errors in parentheses

All usual controls' coefficients are not reported.

Constant and dummies coefficient are not reported.

Table 9: Multinomial regressions. Southern and Northern competition by Pavitt classification.

answered positively to one of these questions are considered credit constrained:(a) did the firm desire more credit at the given interest rate?; (b) would have the firm paid higher interest rate in order to obtain credit?; (c) did the firm ask more credit without obtaining it?. The percentage of firms with self-declared financial constraints is 14.6% in the first, 19.9% in the second and 13.9% in the third survey. This measure may suffer of endogeneity as well as mis-reporting problems. The first arises since firms that declare not to receive enough credit may be cut out from credit because of their bad performance readable from balance-sheet indicators. The measurement error or mis-reporting problem is instead a common feature of surveys on sensitive questions (like this one).

I follow previous studies and consider an IV procedure in which the self-declared credit constraints measure is instrumented with an indicator of liquidity (cash flow);<sup>27</sup> localization of the main bank; number of banks a firm has credit relationships with and the share of debt that a firm has with its main bank.<sup>28</sup>

I show results in table 10. The first stage regression (column (1)) shows that the set of instruments captures quite well the exogenous part of self-declared credit constraints. Moreover the F-test of the first stage is considerably higher than 10, thus instruments are not weak (it is so also when controls are introduced in column (5)). More liquid firms, those whose main bank is localized in the same province, those whose main bank holds a higher share of the total debt are the ones that declare to be less credit constrained. Less intuitively, firms in relation with a higher number of banks are, instead, more credit constrained. Results in the second-step confirm previous findings. Product innovation responds more to low-wage competition, while credit constraints, which in general affect negatively the innovation attitude of firms, are significant only for process innovation, once all other controls are introduced (columns (6) to (8)).

Next in table 11, I report a specification in which I use a measure of leverage - the level of indebtedness of a firm - and a measure of firm's capability to repay a future debt - the

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<sup>27</sup>The effect of this variable on financial constraints may go in both directions. More liquid firms are less likely to be financially constrained, however it may happen that firms accumulate liquidity when they expect future negative shocks.

<sup>28</sup>Results are the same when I include tangible collateral as an instrument for self-declared financial constraints.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1st stage	innova	product	process	1st stage	innova	product	process
liquidity	-0.039 (13.58)***				-0.043 (8.85)***			
localization b	-0.009 (3.33)***				-0.009 (3.38)***			
numbers b	0.005 (5.16)***				0.004 (4.49)***			
mainshare b	0 (5.24)***				0 (5.13)***			
self declared		-0.585 (6.15)***	-0.393 (4.37)***	-0.786 (7.60)***		-0.238 (2.06)**	-0.065 -0.58	-0.533 (4.20)***
size	0.016 (1.80)*	0.095 (7.94)***	0.079 (6.94)***	0.095 (7.33)***	0.012 -1.29	0.067 (5.40)***	0.043 (3.59)***	0.071 (5.24)***
LDC	0.01 -0.65	0.079 (3.55)***	0.149 (7.03)***	0.055 (2.24)**	0.007 -0.43	0.07 (3.40)***	0.138 (6.85)***	0.047 (2.08)**
exporter	0.017 (2.13)**	0.113 (9.57)***	0.139 (12.47)***	0.075 (5.86)***	0.014 (1.74)*	0.093 (8.23)***	0.12 (10.97)***	0.06 (4.84)***
mkt share	0.281 (1.84)*	-0.194 -0.92	0.184 -0.92	-0.027 -0.12	0.21 -1.31	-0.651 (2.98)***	-0.414 (1.95)*	-0.361 -1.51
productivity					-0.011 -1.25	-0.007 -0.53	-0.029 (2.42)**	-0.013 -0.98
sales					0.006 -0.91	0.023 (3.32)***	0.033 (4.93)***	0.013 (1.70)*
age					0 (2.62)***	0 -1.05	0 -0.08	0 (2.03)**
age squared					0 (2.08)**	0 -0.44	0 -0.3	0 -1.41
group					0.009 -0.98	0.007 -0.53	0.011 -0.89	0.022 -1.56
RD					-0.009 -0.21	0.107 (1.84)*	0.104 (1.83)*	0.117 (1.83)*
corporation					0.042 (2.19)**	0.06 (2.27)**	0.041 -1.61	0.038 -1.32
ISO9000					0.014 (1.81)*	0.073 (6.85)***	0.04 (3.84)***	0.08 (6.84)***
equity					0 (2.39)**	0 (2.64)***	0.001 (3.50)***	0 (2.02)**
year 2001	0.064 (6.31)***	-0.175 (13.60)***	-0.015 -1.22	-0.189 (13.55)***	0.058 (5.66)***	-0.196 (16.16)***	-0.031 (2.66)***	-0.21 (15.75)***
year 2004	-0.001 -0.1	-0.143 (11.20)***	0.096 (7.95)***	-0.24 (17.31)***	-0.006 -0.7	-0.162 (13.49)***	0.08 (6.84)***	-0.261 (19.72)***
Constant	-0.091 -0.32	0.878 (2.11)**	-0.228 -0.58	0.771 (1.70)*	0.009 -0.03	1.199 (3.07)***	0.251 -0.66	1.072 (2.50)**
Observations	10373	10373	10373	10373	10326	10326	10326	10326
R-squared	0.06				0.06			
first stage F stat	60.39				34.72			
ATECO 2-digit FE	YES	YES	YES	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

\*\*\*:significant at the 1% level; \*\*:significant at the 5% level; \*: significant at the 10% level.  
Robust t test are the ones reported. Constant and dummies coefficient are not reported.

Table 10: Self-declared financial constraints (1).

past payments for interests within each firm - as instruments. The aim is to capture better the exogenous part of firm self-declared financial constraints measure, considering these two balance-sheet variables which are good predictors for it. Again, results hold.<sup>29</sup>

Finally I obtain, without reporting them, the same results with other robustness checks. I replicated them inserting tangible collateral as instrument and eliminating outliers. I also use the number of per-capita bank branches instrumented with its correspondent in 1936. In fact, since more innovative firms need more financial support it may be the case that in those provinces where more innovative firms are located, banks decide to open more branches, being the demand for their services higher. Recognizing this potential endogeneity, Guiso et al. (2004) propose to use the Italian banking reform of 1936 to construct reliable instruments for actual branches by province. Since then those papers that use this measure of banking development or of financial accessibility, use those instruments. The drawback of this measure is that it does not capture financial restriction at the firm level, somehow imposing the fact that different firms in the same province suffer from the same credit restrictions. With this measure of credit constraints, all results on competition pressure hold. On the contrary, financial constraints affect product instead of process innovation (as in Herrera and Minetti (2006)).

All previous findings are confirmed when I introduce sector time-varying unobserved heterogeneity. Basically I allow for trends and macro-shocks in each sector for the 3 time periods here considered. This is an important robustness check since low-cost countries' imports may have accelerated at different pace in each sector. Again, this robustness check is applicable since the competition pressure measures I rely on, are firm specific.

Unfortunately, since the data set has an insufficient panel structure and since time variation within each firm is scarce for the main variables I use, I cannot conduct the analysis introducing firm-level unobserved heterogeneity. However I introduced all firm-level observables that literature indicates to affect innovation.

Finally, I apply the same methodology using a continuous dependent variable which measures the share of new products sold by firm in each of the 9 years of the surveys. This measure could be used more intensively in a following of this work, since it has a consistent panel dimension. I use a tobit model, to account for the pile-up of zeroes, and find that results, previously

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<sup>29</sup>Regressions in this section are performed with a linear regression model. In general they hold with a IV probit model, too.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1st stage	innova	product	process	1st stage	innova	product	process
liquidity	-0.044 (12.27)***				-0.019 (3.65)***			
localization b	-0.008 (2.99)***				-0.008 (3.01)***			
numbers b	0.001 -1.36				0.002 (1.72)*			
mainshare b	0 (4.56)***				0 (4.06)***			
leverage	0.04 (8.40)***				0.042 (8.89)***			
interests	0.03 (9.88)***				0.043 (12.29)***			
self declared		-0.188 (3.13)***	-0.042 -0.72	-0.336 (5.26)***		0.093 -1.5	0.159 (2.57)**	-0.039 -0.61
size	-0.001 -0.16	0.109 (9.94)***	0.09 (8.47)***	0.11 (9.48)***	0.011 -1.15	0.07 (5.75)***	0.045 (3.76)***	0.074 (5.82)***
LDC	0.012 -0.78	0.07 (3.37)***	0.144 (7.09)***	0.044 (2.01)**	0.01 -0.69	0.064 (3.12)***	0.135 (6.68)***	0.039 (1.83)*
exporter	0.008 -0.96	0.112 (10.28)***	0.14 (13.12)***	0.075 (6.44)***	0.011 -1.29	0.089 (8.00)***	0.119 (10.85)***	0.053 (4.59)***
mkt share	-0.178 -1.16	0.021 -0.11	0.372 (1.98)**	0.222 -1.09	0.113 -0.71	-0.669 (3.13)***	-0.43 (2.03)**	-0.387 (1.73)*
productivity					0 -0.01	0.011 -0.94	-0.019 (1.65)*	0.011 -0.88
sales					-0.056 (8.01)***	0.031 (4.94)***	0.038 (6.16)***	0.025 (3.86)***
age					0 (2.41)**	0 -0.2	0 -0.43	0 -1.03
age squared					0 (1.96)*	0 -0.28	0 -0.58	0 -0.55
group					0.003 -0.31	0.006 -0.43	0.013 -1.01	0.021 -1.56
RD					-0.015 -0.36	0.111 (1.95)*	0.107 (1.89)*	0.124 (2.08)**
corporation					0.041 (2.16)**	0.041 -1.59	0.029 -1.12	0.011 -0.41
ISO9000					0.015 (1.92)*	0.068 (6.55)***	0.036 (3.47)***	0.073 (6.70)***
equity					0 (2.21)**	0 (2.28)**	0.001 (3.19)***	0 -1.54
year 2001	0.05 (4.91)***	-0.19 (16.29)***	-0.028 (2.43)**	-0.206 (16.68)***	0.052 (5.03)***	-0.207 (17.97)***	-0.039 (3.37)***	-0.225 (18.72)***
year 2004	0.002 -0.2	-0.136 (11.59)***	0.103 (8.99)***	-0.232 (18.60)***	0.009 -1.04	-0.16 (13.49)***	0.083 (7.08)***	-0.256 (20.62)***
Constant	0.232 -0.83	0.658 (1.73)*	-0.417 -1.12	0.515 -1.27	0.171 -0.6	1.083 (2.83)***	0.185 -0.49	0.904 (2.26)**
Observations	10229	10229	10229	10229	10182	10182	10182	10182
R-squared	0.08				0.09			
first stage F stat	87.37				79.39			
ATECO 2-digit FE	YES	YES	YES	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

\*\*\*:significant at the 1% level; \*\*:significant at the 5% level; \*: significant at the 10% level.  
Robust t test are the ones reported. Constant and dummies coefficient are not reported.

Table 11: Self-declared financial constraints (2).

obtained with the discrete product innovation measure, hold also for the continuous variable.

## 4 When do financial constraints matter?

In this section I investigate if financial constraints matter in combination to competition from low-wage countries. I do this in two steps. In the first step, I report a preliminary analysis in which I show that even if low-wage competition hit firms' sales, those firms which implemented product innovation performed better than the others. By suggesting that product innovation was an optimal strategy to low-wage competition, this result leaves the open question of why Italian firms did not react more along this line. In the second step I explore if financial constraints, which previous analysis showed not to matter for product innovation, become relevant once interacted with low-wage competition. The idea is that, even if on average, banks do not prevent firms to introduce product innovation, it may be the case that, when low-wage competition becomes binding, then bank-firm relation changes.

In table 12 I show the correlation between firms' sales and innovation choices. The main variables are three dummies capturing the introduction of product innovation alone (PROD), process innovation alone (PROC) or both kind of innovations (BOTH) (column (1)). In column 2 I interact each indicator for innovation activity with low-wage competition. Results show that even if low-wage competition reduces sales by 11.2%, the adoption of product vs process innovation had asymmetric effects. *Ceteris paribus*, those firms that introduce new product in the market, reduce their sales by only 1.6%. Notice also that product innovation has no effect *per se* on sales, it is only its interaction with low-wage competition that eases the downturn of firm sales.

Similar patterns are found when other controls are included (column(3)).<sup>30</sup> In column (4) I introduce the Northern competition indicator as well as its interaction with innovation strategies. This specification allows to understand how the two innovation strategies had different effects for beating competition from low-cost vs high-wage countries. Both Southern and Northern competition reduce sales (29.5% and 23.8% respectively). However the introduction of product innovation alone eases the negative effect for firms with Southern competition

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<sup>30</sup>Notice that I use the same set of controls of previous analysis since many of these variables are firms indicator which can be useful in predicting the amount of sales a firm produces.

(LDC\*PROD is positive and significant) while the introduction of process innovation alone does not help them (LDC\*PROC is not significant). The other case is relevant for Northern competition, being DC\*PROC positive and significant and DC\*PROD not significant.

To assess the validity of previous results, I consider only those firms that answered the three surveys. I then regress their profits in the last available year over the innovation choices and the competition pressure reported in the first survey. This exercise helps in two directions. First, it considers a time structure that allows innovation choices to become productive for the firm. Second, by selecting only firms in the three surveys, results are not driven by firms that enter or exit the data set and that have biased characteristics for unknown reasons.<sup>31</sup> Results confirm previous ones. The introduction of product innovation alone counterbalances the profits reduction for firms which experience low-wage competition.<sup>32</sup>

All in all, these preliminary findings provide some support to the hypothesis that product innovation was a winning strategy which firms should have adopted widely in past decade.

As already noticed I cannot infer whether the firms that exited the data, exited also the market. On the other hand, I am sure to observe firms that did not die. So, in a sense, I am observing only successful firms and, previous results on product innovation, are referred to them only. There is, in fact, a wide consensus on the severity with which Italian firms were hit by the increase of competition from low-wage countries and on the sluggishness of their answer. Thus even if successful firms react properly, I cannot exclude that previous analysis is overestimating the true impact of low-wage competition on firms incentive to innovate. If this is the case an open question arises: what has prevented the optimal answer of Italian firms? In other words, why not all firms reacted by innovating their products? Among the possible answers, I investigate if financial constraints had a role in this. Given the small size of Italian firms, it may be that financial constraints may become binding if a firm decide to innovate to respond to Southern competition.

To investigate this possibility I build on previous analysis and I introduce in all regressions an interaction term between each measures of financial constraints and the low-wage competition

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<sup>31</sup>Unfortunately, once I try to fully exploit the panel dimension introducing firms fixed-effects, none of the variables introduced in these regressions is significant. This may be the result of a scarce variation within firms of low-wage competition as well as innovation choices.

<sup>32</sup>Results are not reported in the paper.



	(1)	(2)	(3)	(4)	(5)
	sales	sales	sales	sales	sales
PROD	0.014	0.007	0.007	0.005	0.011
	-1.54	-0.68	-0.82	-0.51	-1.42
PROC	0.028	0.026	0.027	0.016	0.025
	(3.95)***	(3.58)***	(4.45)***	(2.52)**	(4.28)***
BOTH	0.045	0.037	0.041	0.027	0.044
	(5.67)***	(4.47)***	(6.14)***	(3.50)***	(6.70)***
LDC	-0.045	-0.112	-0.071	-0.295	
	(3.89)***	(5.69)***	(4.39)***	(13.49)***	
LDC*PROD		0.096	0.096	0.105	
		(3.14)***	(3.79)***	(4.08)***	
LDC*PROC		0.04	0.005	0.022	
		-1.16	-0.17	-0.79	
LDC*BOTH		0.126	0.106	0.138	
		(4.66)***	(4.76)***	(6.06)***	
DC				-0.238	
				(15.55)***	
DC*PROD				0.02	
				-1.41	
DC*PROC				0.054	
				(5.08)***	
DC*TOT				0.066	
				(6.35)***	
LDC pure					-0.105
					(4.92)***
LDC pure*PROD					0.098
					(2.80)***
LDC pure*PROC					0.079
					(1.70)*
LDC pure*TOT					0.146
					(4.33)***
exporter	0.019	0.019	0.012	0.013	0.012
	(2.86)***	(2.89)***	(2.23)**	(2.33)**	(2.22)**
mkt share	4.760	4.784	3.928	4.078	3.888
	(31.77)***	(31.87)***	(31.30)***	(32.37)***	(31.09)***
productivity			0.433	0.432	0.432
			(87.74)***	(87.28)***	(87.66)***
age			0	0	0
			-0.1	-0.05	-0.13
age squared			0	0	0
			-0.38	-0.51	-0.37
group			0.041	0.041	0.041
			(7.06)***	(7.04)***	(7.05)***
RD			0.073	0.083	0.074
			(2.47)**	(2.81)***	(2.49)**
corporation			-0.016	-0.015	-0.016
			-1.18	-1.17	-1.24
ISO9000			0.107	0.121	0.107
			(15.38)***	(17.22)***	(15.34)***
equity			0.001	0.001	0.001
			(6.14)***	(7.05)***	(6.06)***
Observations	33067	33067	32770	32770	32770
Number of firms within	8514	8514	8483	8483	8483
ATECO 2-digit FE	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

\*\*\*:significant at the 1% level; \*\*:significant at the 5% level; \*: significant at the 10% level.  
Robust t test are the ones reported. Constant and dummies coefficient are not reported.

Table 12: Sales, Innovation and Competition.

indicator. Would this interaction term being positive, then those firms that were less financial constrained would have been able to adopt product innovation with a higher probability, once hit by competition from low-wage countries. Results indicate that financial constraints, either measured with balance-sheet collateral (tangible asset) or with self-declared indicator, were not an obstacle to the innovation strategy of firms hit by low-wage competition. In fact the interaction term is positive but not statistically significant at conventional levels.<sup>33</sup>

Thus, this preliminary analysis suggests that product innovation is a winning strategy in response to low-wage competition and that financial constraints have no role in the way firms respond to it. In fact access to bank credit, measured with firm collateral, does not prevent the adoption of product innovation by firms neither on average, neither for firms who face low-wage competition in particular.

## 5 Conclusions

I examine the effects of low-wage competition and financial constraints on the innovation strategies of Italian firms over the last decade.

First, I find that innovation is positively correlated with low-wage competition, even when high-wage competition is taken into account. In other words, the Schumpeterian effect, according to which tougher competition reduces firm incentives to innovate, is strongly rejected.

Second, I find that firms escaped low-wage competition by adopting product, rather than process, innovation - a strategy pursued, in particular, by firms in *high-tech* and *specialized* sectors. This result, which is robust to many specifications, reveals that firms adopt a ‘defensive strategy’ specific to the competition (low-quality) they face. On the other hand, in fact, Northern competition induces both quality upgrading and cost-reduction innovation. Moreover, preliminary results on the relation between firm performance, low-wage competition and the kind of innovation adopted suggest that even if on average firms exposed to low-wage competition have lower sales, the adoption of product innovation relaxes this negative outcome. This, together with the fact that I observe only successful firms, provides some supports to the hypothesis that adopting product innovation was a winning strategy to respond to low-wage

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<sup>33</sup>This finding does not change once the potential endogeneity of both financial constraints measures and import competition indicator is taken into account.

competition.

Third, for what concerns credit availability, I find that this is an important determinant of process innovation, albeit it is not relevant for product innovation. The latter seems to be financed mostly with internal resources.

Taken as a whole, results suggests many policy implications. First, innovation aimed at diversifying firms' product should be incentivated in *traditional* sectors, either by strenghtening the appropriability of innovation outcome in those sectors either by subsidying its costs. Second, banks and firms should cooperate more with respect to the adoption of product innovation. Third, if introducing product innovation is a winning strategy to escape competition from low-wage countries, then bank-firm relations become even more important in periods of trade shocks.

Future research is needed along many directions. First, it would help to find information on firms that exited the market to further assess the importance of product innovation as winning strategy against low-wage competition. Second, an interesting question concerns the absence of bank-firm relation with respect to product innovation and the causes of this phenomenon. Possible determinants include riskiness of this type of innovation, moral hazard in disclosing information, the difficoulties in evaluating product innovation outcomes.

## References

- Aghion, Philippe, Rachel Griffith and Peter Howitt** 2006. U-shaped relationship between vertical integration and competition: Theory and evidence; *International Journal of Economic Theory* 2, 351-363.
- Angelini, Paolo and Andrea Generale** (2008); On the Evolution of Firm Size Distributions; *American Economic Review* 98(1), 426-438.
- Becker, Sascha O. and Peter H. Egger** (2007); Endogenous Product versus Process Innovation and a Firm's Propensity to Export; *CESIFO Working Paper*, N. 1906.
- Benfratello, Luigi, Fabio Schiantarelli and Alessandro Sembenelli** (2008); Banks and Innovation: Microeconomic Evidence on Italian Firms; *Journal of Financial Economics*, 197-217.
- Bernard, Andrew, Bradford Jensen, Stephen Redding and Peter Schott** (2006); survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of U.S. Manufacturing Plant; *Journal of International Economics* 68, 219-237.
- Bernard, Andrew, Bradford Jensen, Stephen Redding and Peter Schott** (2007); Firms in International Trade; *Journal of Economic Perspectives* 21(3), 105-130.
- Bloom, Nicholas, Mirko Draca and John Van Reenen** (2011); Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity; *Working Paper, mimeo*.
- Bugamelli, Matteo, Silvia Fabiani and Enrico Sette** (2010); The pro-Competitive Effect of Imports from China: an Analysis on firm-level Price Data ; *Bank of Italy, Temi di Discussione* N. 737.
- Bugamelli, Matteo and Alfonso Rosolia** (2006); Produttività e Concorrenza Estera; *Rivista di politica Economica* 9-10, 55-87.
- Bustos, Paula** (2005); Impact of Trade on Technology and Skill Upgrading: Evidence from Argentina; *UPF Working Paper*.

- Bustos, Paula** (2011); Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms ; *American Economic Review* 101(1), 304-340.
- Caggese, Andrea and Vicente Cuñat** (2008); Financing Constraints and Fixed-Term Employment Contracts; *The Economic Journal* 118(533), 2013-2046.
- Cohen, Wesley M. and R.C. Levin** (1989); Innovation and Market structure; Handbook of Industrial Organization, Volume 2, 1989, 1059-1107.
- Cohen, Wesley M. and Steven Klepper** (1996); Firm Size and the Nature of Innovation within Industries: the Case of Process and Product R&D; *The Review of Economics and Statistics* 78, 232-243.
- Finicelli, Andrea, Patrizio Pagano and Massimo Sbracia** (2012); Ricardian Selection; *Journal of International Economics*, forthcoming.
- Guiso, Luigi, Paola Sapienza and Luigi Zingales** (2003); The Cost of Banking Regulation; Chicago Graduate School of Business, *mimeo*.
- Guiso, Luigi, Paola Sapienza and Luigi Zingales** (2004); Does local financial development matter?; *Quarterly Journal of Economics* 119, 929-969.
- Hall, Bronwyn H., Francesca Lotti and Jacques Mairasse** (2009); Innovation and Productivity in SMEs. Empirical Evidence for Italy. *Bank of Italy, Temi di Discussione* N. 718.
- Herrera, Ana Maria and Raoul Minetti** (2007); Informed Finance and Technological Change: Evidence from Credit Relationship; *Journal of Financial Economics* 83, 223-269.
- Lelarge, Claire and Benjamin Nefussi** (2008); Exposure to low-wage Competition, Activity Changes and Quality Upgrading: an Empirical Assessment; *working paper, mimeo*.
- Magri, Silvia** (2007); The Financing of Small Innovative Firms: the Italian Case; *Bank of Italy, Temi di Discussione* N. 640.
- Melitz, Marc** (2003); The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity; *Econometrica* 71(6), 1695-1725.

- Ongena, Steven and David C. Smith** (2000); What Determines the Number of Bank Relationships? Cross-country Evidence; *Journal of Financial Intermediation* 9, 26-56.
- Ongena, Steven and David C. Smith** (2001); The Duration of bank Relationships; *Journal of Financial Economics* 61, 449-475.
- Pagano, Patrizio and Fabiano Schivardi** (2003); Firm Size Distribution and Growth; *Scandinavian Journal of Economics* 105(2), 255-274.
- Rivers, Douglas and Hoang Vuong** (1988); Limited information estimators and exogeneity testing for simultaneous probit models; *Journal of Econometrics* 39, 347-366.
- Sevignac, Frederique** (2006); The Impact of Financial Constraints on Innovation: Evidence from French Manufacturing Firms; *CREST working papers*.
- Schumpeter, Joseph A.** (1942); Capitalism, socialism and democracy; *Harper*, New York.
- Schott, Peter** (2004); Across-Product versus Within-Product Specialization in International Trade; *Quarterly Journal of Economics* 119, 647-678.
- Thoenig, Mathias and Thierry Verdier** (2003); A Theory of Defensive Skill-Biased Innovation and Globalization; *American Economic Review* 93(3), 709-728.