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The Effects of Product Dropping on Firm's Productivity and Employment Composition

by

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ABSTRACT

Recent literature on heterogeneous multi-product firms predicts that elimination of marginal (less productive) products, due to fiercer competition, leads to an increase of firm efficiency. We test this prediction in the case of a sample of Italian firms during a period (2000-05) of rising competitive pressures. Adopting a propensity score matching estimator, we find evidence of a causal relationship between product dropping and higher firm productivity. We also find evidence that product dropping activity causes a fall of the share of blue collars versus white collars. We draw some policy implications regarding labour market adjustment and support to internal product switching when competition shocks take place.

Keyword: product dropping, matching estimator, white collar.

JEL CODE: D20; L23; L60

CONTENTS

1. INTRODUCTION

Recent literature on firms' heterogeneity abandons the assumption of single-product firms and moves a step forward towards a more realistic representation of firms' behaviour by considering that most firms, and particularly the exporting ones, are multi-product. Empirical studies show that multi-product firms (MPFs) change the number of goods they produce (within-firm extensive margin) and the amount of per-good output (within-firm intensive margin) both along the cycle and in response to competition shocks (see Bernard et al. 2006a, Broda and Weinstein 2007, Bilbiie et al. 2008, Mayer and Ottaviano 2007, Arkolakis and Muendler 2008, Iacovone and Javorcik 2008).

Several theoretical models have been recently proposed to rationalize the way firm-level productivity improves as within-firm product switching takes place following fiercer competition (Bernard et al. 2006b, Feenstra and Ma 2008 Eckel and Neary 2008, Mayer et al. 2009). Despite quite different frameworks, these models share basic common features: i) productivity is different across products, so that each MPF is characterised by a product ladder in terms of productivity, with core competencies at the top of it; ii) firm productivity is affected by product scope and product mix; iii) rise in competition improves firm productivity as firms reallocate internal resources, focusing on core competencies, shedding less productive marginal products and enlarging the amount of best products that are manufactured and sold.

Taking stock of this theoretical background, we test the causal relationship between "intra-muros" product dropping activity and firm-level productivity for Italian exporters during the period 2000-2005. The Italian case is interesting for such testing since firms in this country were affected in the considered years by relevant competition shocks, such as the Euro-adoption (1999), the Chinese integration in world trade (WTO-membership in 2001) and the zeroing of protection coming from the Multifiber agreement (whose phasing out completed in 2005). These shocks were common to all European countries and diffused across sectors, yet they especially impacted Italian manufacturing, courtesy of its specialization in traditional industries and the frequent resort in former years to exchange rate adjustments to re-align domestic costs to those of competitors (see Bugamelli et al. 2008, Bank of Italy 2008).

Besides the impact on productivity, we investigate in the same dataset the relationship between product dropping and within-firm changes in composition of labour-force (white vs. blue collars). There isn't much theorizing on this in the literature. Verhoogen (2008), analysing the Mexican case, builds a model where a boost to exports leads to enlarge, within-industry, the share of high-quality

plants that are intensive of white collars (higher-quality workers). To the extent that more productive goods manufactured by a firm are intensive of higher-quality workers, a similar mechanism may be supposed to be at work when within-firm resource reallocation takes place in response to competition shocks: focusing on core-competencies and shedding marginal products would lead to a larger share of white collars in the labour force of the firm.

The paper is organized as follows. Section 2 provides a brief description of the dataset. Section 3 illustrates the empirical strategy and result in testing causality between product dropping and productivity. The causal effect of dropping activity of products on employment composition within firms is investigated in section 4. Conclusions are in section 5.

2. DATABASE

The database is a firm-level matched dataset involving information gathered, respectively, by ISTAT (Italian National Statistical Institute) and ISAE (Institute for Studies and Economic Analyses). The data involves about 9,000 firms observed over the time period 2000-2005. Specifically, micro-data from the PRODCOM surveys (ISTAT), containing firm-level statistics on the production of manufactured goods, were linked to the corresponding information (at firm level) contained in ISAE business surveys on exporting enterprises. De Angelis and Pappalardo (2009) provide description of the merging methodology followed to match the two statistical sources and details on the obtained results. The PRODCOM database provides information of both on the extensive (number of products produced by the firm at the 8-digit level of the NACE REV2 classification) and the intensive margin of the firm (per-product output); moreover, it allows the construction of an indicator of firm-level labour productivity (real product per worker), which is the crucial variable in the theoretical framework of firm heterogeneity. The ISAE business survey on exporting firms provides specific information on the decision to export at enterprise level, the number of destination markets, the share of goods exported in terms of total turnover, specific obstacles faced by entrepreneurs during both producing and exporting activity, the level of current production activity, the decision to delocalize a part of the production, the number of countries in which the delocalization takes place and the share of blue collars over total workers. We use ISAE information to single out exporting firms from the PRODCOM datasource and to construct the treatment experiment relevant

for empirical testing. Table 1, provides a summary of descriptive statistics of the variables used in this paper.

Table 1 **Structure of the dataset (years 2000-2005)**

Variables	N	Average	Standard Deviation	Minimum	Maximum
Export/total turnover (%)	9,432	22.6	28.0	0	100
(Log) turnover/employee constant price	9,432	3.96	1.25	-3.83	13.00
Drop (dummy)	2,805	0.24	0.43	0	1
Number of employees	9,432	159.5	514.4	3	10,082
Share of blue collar	4,175	0.75	0.21	0	1
Unit price of product sold (euro)	9,432	12.72	87.27	0	2,992.73
High production (dummy)	6,265	0.37	0.48	0	1
Medium production (dummy)	2,951	0.58	0.49	0	1
Delocalization (dummy)	7,534	0.05	0.22	0	1
Number of delocalized countries	7,534	0.07	0.33	0	3

Source: ISAE PRODCOM dataset.

3. PRODUCT DROPPING AND PRODUCTIVITY

In this section we aim at testing the existence of a causal relationship between product elimination and productivity for exporting firms. The working hypotheses is a positive relationship, namely the activity of dropping products causes productivity to rise.

Usually, the simplest way one can conceive to analyze a relationship between two variables, say product switching and productivity, is to run a regression of the type

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\delta}\mathbf{D} + \mathbf{u} \qquad (1)$$

where:

y is a vector of firms productivity, **X** is a matrix of covariates, **D** is a binary dummy that switches on and off when products have been dropped or not, finally **u** is the usual error term in vectorial form supposed to be i.i.d.

To our purpose, the attention is focused on the δ coefficient. We want to ascertain whether the firms that dropped lines of production from their product menu, benefited from an increase in productivity attributable to this peculiar product switching strategy. From another perspective, looking at firms that have

dropped products as “treated” units, the aim of the analysis is to work out the Average Treatment Effect for the Treated, ATT.

In economics the treatment decision is always made on a voluntary base, that is, in our context the firms have self selected in deciding if and when dropping products. The self-selection phenomenon induces endogeneity between **u** and **D**, quite likely resulting in a positive selection bias, i.e. an overestimate of **δ** when (1) is estimated with OLS. Formally E(**D’u**)≠0. More productive firms have greater firm-level ability. As such they are more reactive to a changing economic environment, hence they are more likely to opt for product switching strategies. This is nothing but a restatement of the well known problem of unobservable heterogeneity. Instrumental variables do not completely solve the problem for two reasons. Firstly, there is an objective difficulty in finding good instruments; secondly, at the very best the information they can provide is partial, because the instrumental variables estimator is unable to work out the ATT, but rather it estimates the Local Average Treatment Effect, LATE[1]. The latter is the average effect computed on a sub population, precisely on those units who are sensible to the instrument (Angrist 1990, Angrist et al 1996).

Notice also that a difference in difference estimator, DID, cannot be implemented to estimate (1) because it requires a neat date from which firms are allowed to be treated and the database must contain data prior and after the treatment. This situation typically arises when the treatment status is allowed by law starting from a given date (see for an example Zecchini and Ventura, 2009). In our case we can have, and indeed we have, firms treated in the first year of the sample. Yet, the Heckman estimator does not help in overcoming the problem of finding a good instrument and, moreover, puts some additional assumptions on the distribution of the errors (Heckman 1978, 1979).

These technical considerations have led us to choose the propensity score matching as the most suitable estimator[2]. Table 1 reports the results.

The propensity score has been estimated through a Logit regression. The dependent variable is a dummy, **D** in the notation of (1), representing the treatment variable, that takes on 1 when the firm has dropped products at least once in the 2000-2005 period, and zero otherwise. The regressors are: sectoral and territorial dummies, delocalization dummy (0=no delocalization;

1 A further different route is followed by De Nardis and Pappalardo (2009) who adapt a panel Tobit model to an IV framework using the two-stage procedure suggested by Newey (1990). Chosen instruments give rise to a quasi-experimental identification that splits firms in a treatment and a control group in a way that is random with respect to firms’ export behaviour.

2 For more technical details about the propensity score matching estimator we refer the interested reader to Angrist and Pishcke (2008) and Wooldridge (2002).

1=otherwise), number of countries in which the delocalization takes place, total number of workers, share of blue collars, unit price of products sold, dummies indicating the current level of product capacity (high, medium and low). All the variables are referred to the final year of the dataset, 2005[3]. The fitted probability from this regression is then used to form the cells over which the average difference in productivity between treated and non-treated at 2005 is figured out. Our intuition is that there may be a time lag between the cause and the effect, it may take years for a firm to reasonably expect an effect from product switching to productivity. For this reason we have coded **D** as described above, such to inquire into the causal effect between product switching carried out over the period 2000-2005 and its (possible) effect in 2005. In such a way the estimate can capture both contemporaneous and lagged effects. In more details, the matching propensity score has been applied to variables referred to the final year, 2005, of the ISAE-PRODCOM database, with the peculiarity that the dependent (treatment) variable, **D**, even though a vector in cross section form, is constructed considering the product-dropping action of the firm over the entire sample period (2000-2005).

The first column of Table 2 shows the computing algorithm thereby the propensity score matching has been implemented. The second column reports the number of treated versus the non-treated units. The third column reports the estimates of the ATT. The sign of the ATT is robust to the different algorithms, being always positive, as predicted by the theory. The same cannot be said for the significance, as only two cases out of five are significant at the conventional levels. However, this result is affected by the different relative dimension of the two groups when applying different algorithms. In general, whenever there is a strong unbalance between treated and non-treated units the matching estimator gives rise to large standard errors. As such, the non significant causal effect found in the first three rows of Table 2 is likely to stem from the sample composition, rather than from a true non significant effect. On the other hand, when the ratio between treated and non-treated is closer to one (fourth and fifth row in Table 1) we find a significant effect of drop on productivity. As in this last occurrence the total number of units in the sample drops dramatically, the standard errors have been bootstrapped increasing the reliability of their estimates. All in all, when there is an adequate balancing between the two

3 The authors do not report the Logit estimate in the text, however evidence can be given to the interested reader upon request. The balancing property is satisfied for all the variables in all the estimates. For more details on the balancing property and its implementation in STATA see Dehejia and Wabba (2002) and Becker and Ichino (2002).

groups of firms one cannot reject the theory prediction that dropping products causes an increase in productivity.[4]

Table 2 Estimate of the ATT of Drop on (log) of real productivity (turnover per employee at constant prices) for exporting firms

Algorithm	Treated (non-treated)	ATT
Stratification	61 (332)	0.233 (0.196)
Kernel	61 (332)	0.198 (0.197)
Radious	61 (332)	0.128 (0.190)
Nearest neighbour (equal weights)	61 (50)	0.682** (0.300)
Nearest neighbour (random draw version)	61 (50)	0.682** (0.300)

Number of control units in parenthesis in the second column. SE in parenthesis in the third column. "***", "**" and "*" respectively denote 1%, 5% and 10% significance level. SE have been bootstrapped with 200 replications as suggested by Moonye, Duval (1993).

4. PRODUCT DROPPING AND EMPLOYMENT COMPOSITION

In this section we investigate the relationship between the firms' activity of product dropping and the labour force composition of the firm, which should be strictly related to the phenomenon analysed in former section. Heterogeneous-firm theory does not explicitly tackle the issue of the (possible) effects of dropping products on the labour force composition within the firm, although intuition suggests, as discussed in the introduction, that mechanisms of worker selection within MPFs could be similar to those operating within multi-firm industries, provided that products characterised by different productivity require different proportion of high/low skilled workers (see Verhoogen 2008). On the empirical side, Bugamelli et al. (2008) argue that Italian industry reacted to the pressure coming from low-cost countries and the end of the exchange rate adjustments by reorganizing and investing in vertical (quality upgrading) as well

4 This finding is similar to what found in other studies. Following a causal approach and using a different dataset, Matteucci and Sterlacchini (2009) address a question similar to ours. Inquiring on the effect of product innovation on firm-level total factor productivity (TFP), they find that product innovation causes TFP to increase by 65% over three years 1998-2000 for Italian firms. Although the definition of product innovation is broader the one we adopt and although TFP is not exactly the same measure we use as for firm efficiency, Matteucci and Sterlacchini's result is in line with the ones we obtain, with the magnitude of the estimates strikingly close.

as horizontal (marketing, branding, product design, etc.) differentiation. They also provide some evidence, using a different dataset, that these internal changes were correlated in some industries with modifications in employment composition within the firm, with an increasing share of high-skilled workers (identified with the white collars).

We take up this issue and test the existence of a causal effect going from product dropping to the ratio of blue collars relative to total workers within the firm.

Table 3 Estimate of the ATT of Drop on the share of blue-collar workers for exporting firms

Algorithm	Treated (non-treated)	ATT
Stratification	109 (803)	-0.032 (0.032)
Kernel	109 (803)	-0.035 (0.032)
Nearest neighbour (equal weights)	109 (52)	-0.067* (0.037)
Nearest neighbour (random draw version)	109 (52)	-0.067* (0.037)

Number of control units in parenthesis in the second column. SE in parenthesis in the third column. "***", "**" and "*" respectively denote 1%, 5% and 10% significance level. SE have been bootstrapped with 200 replications as suggested by Moonye, Duval (1993).

The structure of Table 3 closely follows that of Table 2, except for the fact that the algorithms are four instead of five as the radious cannot be implemented[5].

In this case too the signs of the estimated ATT do not vary across the different algorithms, but only two out of four are significant although at a 10% level. The same *caveat* about the unbalance between treated and non-treated individuals applies as in Table 2: a relatively significant effect comes out only when the ratio between the two groups is closer to unity. Therefore, the basic intuition cannot be rejected at a 90% probability level: it is possible to claim that there is some evidence that on average dropping products caused an increase (decrease) in the share of more (less) skilled workers. This result allows to infer

5 Differently from the analyses carried out on productivity, in this case the reference year to verify the effect of dropping products is 2004, as the information about the labour force composition are available only for the years 2000 and 2004 in the database. Accordingly, the dependent variable, drop, takes on 1 if the firm has dropped products at least once over the period 2000-2004 and zero otherwise. The regressors of the Logit estimate are: sectoral and territorial dummies, delocalization dummy, number of countries in which the delocalization takes place, share of revenue from exporting, unit price of products sold, dummies for the current level of product capacity (high, medium and low). All the variables are referred to 2004. The balancing property is satisfied for all the variables in all the estimates.

that the dropped products, besides being the less productive (see former section), were probably also those with lower human capital content. Such an evidence can be regarded as confirmation of the argument of a gradual shift of Italian firms, whatever the pertaining sector, towards productions of better quality and with higher human capital content (see Bank of Italy 2009, Lissovolick 2008).

These findings have some relevant implications for the labour-market adjustment following competitions shocks to the tradable sector. To the extent that a competition-induced productivity increase is brought about by product selection processes taking place within the firm, there could be a mitigation (although not a complete elimination) of the costs of adjustment for the labour force: in fact, it is easier to relocate (if necessary, after e period of training) displaced workers from dying to surviving (and expanding) lines of production within the same firm than to move workers from a dying to a surviving firm, especially if these firms pertain to distinct sectors and request different workers' specialization.

5. CONCLUDING REMARKS

Models on heterogeneous MPFs point out that the intra-firm activity of product pruning is a fundamental force in determining rise of firm productivity, as it subtends stronger focus of producers on their core competencies where efficiency is higher. We have tested this causal relationship for a sample of Italian exporters, finding that, when allowing for adequate balancing between treated and non-treated units, dropping products actually leads to higher productivity. Moreover, on the assumption that pruned products are the marginal ones, characterised by higher intensity of blue-collars (low-skilled workers), we have tested the causal effect that goes from product dropping to change in employment composition, finding some (although weaker) evidence of a fall of the share of blue collars induced by product elimination, when treated and control groups are adequately balanced.

These findings have some relevant implications for the economic policy design. First, it may be not sufficient to judge the extent of an adjustment process, following a competition shock, from the amount of churning in the population of producers: much (or even the larger part) of the adjustment may take place within the firm. Second, the importance of the intra-firm margin of adjustment may make the cost of relocating displaced labour force, following a competition shock, lower than what is generally deemed, since an important

chunk of the relocation process takes place within the same firm. Corollary to all this is that policy measures aimed at encouraging within-firm product switching (e.g., removal of credit rationing, incentives to innovation, contribution to research laboratories, firm-level training of workers) may be not less important than interventions directed to facilitate labour mobility between firms.

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