A generalized ordered logit approach to evaluate industrial policy in Italy

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The evaluation of industrial policy is strictly related to the concept of deadweight which facilitates an assessment of the additional impact of financial assistance provided by the public sector. The prime focus of the current paper is to develop an econometric model to evaluate industrial policy interventions. In so doing, the paper provides an empirical strategy designed with the aim to quantify the impact of firm characteristics on different degrees of deadweight effect. We use an investigation based on a huge sample (25000 firms) of Italian firms carried out by MET in 2009.

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I. Introduction

The volume of total state aid in Italy in 2008 amounts to about 0.28% of Italian GDP[1] covering several objectives among which stimulating R&D and innovation activity, green investments and promoting new employment. An important issue in the evaluation of industrial policies is trying to understand whether the policy makers' interventions have significant effects on new additional activities. Public subsidies are usually considered as a distortion of competition among firms; nevertheless an efficient use of these tools, might allow to improve interregional equity reducing at the same time market failures. Thus, distortions are just a little price to pay in increasing national performances (Felsenstein *et al.*, 1998). In many evaluation exercises the main problem is to determinate what would have happened without subsidies and then to define the counter-factual scenario (Blundell and Costa Dias, 2000; Khandeker *et al.,* 2010, among others).

Counter-factual approach in evaluating the effectiveness of an industrial policy might present some problems related to the identification of the counter-factual group caused by self selection bias.

This paper follows a different approach originally developed by Tervo (1990) and Lenihan (2004). Exploiting the data of a huge survey on Italian firms we overcome the problem of counterfactual identification, asking subsided firms to evaluate what would have happened without public subsidies. In this way, we evaluate the effectiveness of public aids concentrating on the concept of deadweight (which measures the effects of industrial grants on the firm economic activities).

Even if a large part of literature is devoted to assess the effectiveness of subsides (Holden and Swales, 1995, among others), there is still no consensus about their real efficiency (Harris and Trainor, 2005) and on the importance of the variables used in the different empirical models of deadweight (Wren, 2007).

Presence and magnitude of deadweight effects depend on the characteristics of the firm receiving the grant and on the types of investment projects. Using data for investment projects of Finnish firms, Tokila *et al.* (2009) find that the more a firm is new and big the more deadweight is likely. Regarding Irish industrial policy, Lenihan (2004) shows that smaller firms are less likely to cause deadweight. Moreover, grants oriented to

[1] In the EU-27, this value is about 0.41% of GDP (European Commission, 2008)

increase employment are usually related to a smaller additionality. Finally, Luukkonen (1999) analyses the projects financed by European programs and argues that investments in R&D of SMEs have higher probabilities of failure without assistance.

This paper contributes to the existent literature in two main ways: first of all, we provide new evidences for Italian manufacturing sector using a survey[2] of about 25.000 firms, 600 of which received public subsides.

Moreover, we adopt a generalized ordered logit approach, rather than standard *logit* regression as in Lenihan, (2004), in order to take into account the different intensities of deadweight and to avoid problems related to the violation of parallel-lines assumption of the standard ordered logit regression (Williams, 2006).

II. Estimation approach

According to Lenihan (2004), deadweight is defined as the degree at which projects would have gone ahead without public support: if a firm stated its investment would not have been realised at all, each public contribute would be totally additional (*zero deadweight* situation). In the opposite case the investment would have gone ahead equally and at the same time (*pure deadweight*); industrial subsidies would be totally useless in stimulating additional employment or investments.

In the survey questionnaire it is asked companies if they received grants during the past three years, to indicate the value of the total subsidy and if co-financed investments would have been realised in absence of received grant. The alternative answers were:

(a) Yes, they would have gone ahead as now unchanged.

(b) Yes, they would have gone ahead, but in a slightly reduced scale.

(c) Yes, they would have gone ahead, but in a greatly reduced scale.

(d) Yes, they would have gone ahead but in a later date.

(e) No.

Using these information we define four different categories of deadweight. The resulting ordinal variable takes value: 0 if the answer is (e), 1 if (c) or (d), 2 if the firm answered (b) and 3 otherwise. This allows to easily observe differences among 'pure' deadweight (3), no deadweight (0) and the two different degrees of the partial phenomenon.

[2] Provided by Met, which includes Italian firms grouped by region, sector and size.

Table 1 shows the distribution of this variable: 33.3% of the sample firms fit into the 'pure' deadweight category while 31.81% belongs to the zero deadweight group.

[TABLE 1]

As stressed by Williams (2006), the violation of the parallel-line assumption[3] can produce errors in the estimation of the coefficients in a standard ordered logit model. For this reason, we adopt a generalized ordered logit approach allowing the variation of the coefficient values among different categories of the ordinal variable[4].

$$P(Y_i > j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1+\left[\exp(\alpha_j + X_i\beta_j)\right]}, j = 0,1,2 \quad (1)$$

Where, Y_i is the ordinal dependent variable, j is the number of *deadweight* categories, X_i is the matrix of regressors while β_j contains the coefficients for each realization of *deadweight* variable.

The violation of parallel-line assumption can be tested through a *Brant test* (Brant, 1990) that verifies the null hypothesis of not-violating the assumption for each coefficient[5] and for the overall model using a χ^2 test statistic.

The matrix *X* includes two proxies of firm size, the log of turnover and of the growth rate (2006-2008) of the number of employees and a dummy variable for sector (*manufacturing* takes value 1 if the firm belongs manufacturing sector, 0 otherwise). We use control variables to identify the nature of received grants: *startup_g, investment_g, employment_g, export_g, crisis_g, green_g, and R&D_g*. Finally, we consider a measure of the grant intensity (*lngrant_intensity)* calculated as the (log of) ratio between the value of the grant and total investment of each firm.

III. Empirical results

As preliminary analysis we estimate a standard logit model, constructing a dichotomous, dependent variable for deadweight (in this case it takes value 0 in case of "zero deadweight" and value 1 otherwise)[6]. The main results are reported in Table 2.

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[3] That is the requirement of equality among coefficient values for each state of the dependent, ordinal, variable.

4 With regard to the multinomial logistic regression this approach has the advantages to maintain the ordinal structure of the dependent variable as well as to be more parsimonious in term of coefficient estimations and interpretation.

[5] Using a Brant test it is even possible to estimate partially constrained generalized ordered logit model in which only the coefficients related to those variables that violate parallel assumption are allowed to be varying (without modifying the others).

[TABLE 2]

Firms with higher level of turnover are more likely to display deadweight while a greater value for the employment variable (*lngrowth_empl*) reduces the probability. Thus, while the "pure dimension" variable (*lnturnover*) increases the likelihood of deadweight, the growth rate of employees has a positive impact on the effectiveness of a grant (reduces deadweight effect). The explanation of the lower deadweight for smaller firms is boned to financial features. One would aspect larger firms have access to alternative sources of funding and are able to raise finance from the private sector (Hart and Scott, 1994). The sector dummy is significant and increases the deadweight effect. The higher deadweight for manufacturing firms (positive coefficient of *manufacturing*) could be due to the possibility to have access to alternative fundraise in order to finance investments: the additionality provided by public subsidies is then minor.

A priori, one could expect the necessity of investment subsidies varies between investment projects and increases significantly with the their size and, consequently, with the intensity of assistance (Haapanen *et al.*, 2008). This means that bigger projects are more likely, *ceteris paribus*, to produce "zero deadweight". The higher is the amount of grant, the higher is the probability that the investment would not have been realised without it. This consideration is confirmed by our results that show positive estimated coefficient for the grant intensity variable.

Finally, with regards to the effect of different kinds of grant the estimation suggests that only grants oriented to face a crisis period are significant and efficient (reduce the probability of deadweight).

As second step, we re-estimate the model and the whole coefficients using an ordered logistic regression (results are reported in Table 2), this lets us evaluate the impact of regressors on different degrees of deadweight intensity.

The main evidences seem to confirm previews results: we observe a positive impact of turnover and sector dummy while there is a reduction of deadweight likelihood for greater values of grant intensity and for the variable *crisis_g*. Finally, we find out a reduction in the significance of the employees growth rate.

The problem related to the ordered logit model is that the parallel-lines assumption is often violated in the estimation because it is possible for one or more β_i to differ across

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[6] This approach follows the one used by Lenihan (2004) and it provides a first idea of the relation among all the variables.

values of the dependent variable. Table 3 reports the probability of violating the assumption for each coefficient and for the overall model, according to Brant test (1990). The significant χ^2 test statistic provides evidence that the parallel assumption has been violated and it suggests us to change the estimation approach.

[TABLE 3]

Taking a significance level of 10% the estimated coefficients for *lnturnover, lngrowth_empl, startup_g, employment_g* and *export_g,* all violate the parallel-lines assumption, while the others seem to be constant through each value of the dependent variable. Thus, we use a partially constrained generalized ordered logit model in order to allow the variation only for the coefficients that violate parallel assumption.

In a *gologit* regression, positive coefficients indicate that higher values on the explanatory variable make it more likely that the respondent will be in a higher category of *Y* than the current one. On the other hand, negative coefficients indicate that higher values of the explanatory variable increase the likelihood of being in the current or a lower category.

[TABLE 4]

Table 4 summarizes the main results. Among significant variables we can notice that, once again, *lngrant_intensity* and *crisis_g* have a positive impact on the effectiveness of the public grant. Their negative coefficients suggest that higher values of these variables conduce to a lower likelihood of deadweight. The positive coefficient of the sector dummy, suggests how the probability of a high degree of deadweight increases in firms that operate in the manufacturing field.

Finally, the variable *lnturnover*, violating the parallel-lines condition, has coefficients that differ from each other among the three different steps. Their monotonous variations suggest a precise relation with the dependent variable: the decreasing behaviour in the magnitude of the coefficients provides another evidence of the negative effect of the firm size on grant effectiveness. Thus, the bigger is a firm, the higher is the likelihood of having deadweight.

On the contrary, coefficients of *lngrowth_empl* increase in each step even if the differences are not always statistically significant. This evidence seems to suggest that the higher is the growth rate of the number of employees in a firm, the more is likely a zero deadweight situation.

IV. Conclusions

This paper provided an empirical approach to analyse firm characteristics that are likely to influence deadweight effects of industrial policy in Italy. The approach we developed could have broad-based application regarding the evaluation of various types of government intervention. This paper contributes to the literature on policy evaluation developing an empirical model, which is able to quantify the impact of firms characteristics on different degree of deadweight effects.

Using data for Italian firms, we provide evidence of the fact that deadweight is strictly related to the degree of dynamism of a firm, size, sector, the intensity of received grant and also to the type of investment done through public subsides. For this point it would seem that the most effective type of subsidy in Italy is the crisis grant.

V. References

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VI. Tables

Table 1. Deadweight categories

Deadweight	*Frequence*	*Frequence (percent)*	*Cumulative Frequence*
0	620	31.81	31.81
1	349	17.91	49.72
2	331	16.98	66.70
3	649	33.30	100.00
TOTAL	1949	100.00	.

Table 2. Logit and Ordered logit estimations of deadweight

		Logit		*Ordered Logit*	
Size	*Lnturnover*	0.190	(0.065)***	0.137	(0.051)***
	lngrowth_empl	-0.494	(0.229)**	-0.327	(0.212)
Sector	*Manufacturing*	0.472	(0.208)**	0.524	(0.179)***
Grant intensity	*lngrant_intensity*	-0.367	(0.125)***	-0.33	(0.113)***
Grant type	*startup_g*	-0.170	(0.715)	-0.106	(0.580)
	investment_g	-0.083	(0.213)	-0.136	(0.179)
	employment_g	0.226	(0.362)	0.354	(0.283)
	export_g	0.302	(0.694)	0.068	(0.532)
	crisis_g	-2.030	(0.535)***	-1.928	(0.521)***
	green_g	0.165	(0.557)	0.043	(0.428)
	r&d_g	0.106	(0.223)	0.101	(0.173)
Intercept	*/cut1*	-1.734	(1.006)	1.089	(0.792)
	/cut2	.	.	1.894	(0.792)
	/cut3	.	.	2.707	(0.792)
	Number of Obs.	638		638	
	Chi2(11)	54.750	[0.000]	57.140	[0.000]
	Pseudo R2	0.072		0.033	

Notes: ***,**,* indicate variables significant at the 1%, 5% and 10% respectively. Standard errors in round brackets. P-value in squared brackets.

Table 3. Brant test of parallel regression assumption for the overall model and gologit-autofit test for each variable

Variable	χ^2	$p > \chi^2$
All	204.88	0.000
lnturnover	3.88	0.093
manufacturing	0.04	0.888
lngrowth_empl	5.03	0.073
startup_g	1.56	0.043
investment_g	0.22	0.999
employment_g	2.08	0.051
export_g	4.61	0.032
crisis_g	42.64	0.999
green_g	0.41	0.838
R&D_g	0.06	0.845
lngrant_intensity	2.15	0.378

Notes: The Brant's Wald test (1990) χ^2 statistics for equality of the coefficients in the *generalized ordered logit* (both at system and single variable level) are reported in the second column. A significant test statistic provides evidence that the parallel regression assumption has been violated.

Table 4. Generalized Ordered Logit estimation of deadweight

		deadweight=1		*deadweight=2*		*deadweight=3*	
Size	*lnturnover*	0.198	(0.067)***	0.154	(0.056)***	0.072	(0.056)
	lngrowth_empl	-0.671	(0.290)**	-0.301	(0.292)	0.092	(0.264)
Sector	*manufacturing*	0.521	(0.172)***	.		.	
Grant intensity	*lngrant_intensity*	-0.336	(0.115)***	.		.	
Grant type	*startup_g*	0.313	(0.817)	0.933	(0.791)	-1.086	(0.860)
	investment_g	-0.145	(0.169)	.		.	
	employment_g	0.127	(0.353)	0.587	(0.352)*	0.224	(0.318)
	export_g	-0.242	(0.706)	-1.089	(0.691)	1.364	(0.806)*
	crisis_g	-2.053	(0.521)***	.		.	
	green_g	-0.022	(0.420)	.		.	
	r&d_g	0.105	(0.176)	.		.	
Intercept	*const*	-1.721	(1.06)	-2.151	(0.891)	-1.948	(0.875)
	Number of Obs.	638					
	Chi2(21)	77.63	[0.000]				
	Pseudo R2	0.045					

Notes: ***,**,* indicate variables significant at the 1%, 5% and 10% respectively. Standard errors in round brackets. P-value in squared brackets.