The *Composite* specification ($PB_C$) is obtained by setting $\pi = 1$ and $\tau = 0$. In a similar vein, the well-known *Generalized Translog* (GT) and *Standard Translog* (ST) models, as well as the *Separable Quadratic* (SQ) functional form, can be estimated by imposing simple restrictions on the system (1)-(2)[4].

The PB cost functions originate from the combination of the log-quadratic input price structure of the ST and GT specifications with a quadratic structure for outputs[5]. The relatively few studies which employed the PB specification referred to the banking, telecommunications, and electricity sectors. Overall, the composite model has consistently proved to be successful in obtaining more stable and reliable estimates than the alternative functional forms (see Fraquelli *et al*., 2005 for more details).

The $PB_G$ model proposes to transform both sides of the cost function – from $OHC = C(Y, P)$ to $HOC^{(\phi)} = [C(Y, P)]^{(\phi)}$ – in order to enlarge the set of plausible empirical specifications. The optimal value of $\phi$ can be estimated resorting to standard non-linear least squares routines. The comparison between nested models (i.e $PB_C$ versus SQ and GT versus ST) can be made by using log-likelihoods for the system (1)-(2), while to select between *non-nested* specifications (i.e. $PB_C$ versus GT) it is possible to recur to an adjusted LR statistic (Vuong, 1989).

All the specifications of the multi-product cost function are estimated jointly with their associated input cost-share equations. In our four-inputs case, to avoid the singularity of the covariance matrix of residuals, the equation for administrative staff ($S_{AS}$) was not included in each system. Before the estimation, all variables were standardized on their respective sample means. Parameter estimates were obtained via a non-linear GLS estimation (NLSUR), which ensures estimated coefficients to be invariant with respect to the omitted share equation.

### 2.4. Results: the cost function

The results of the NLSUR estimations for the ST, GT, SQ, and PB models are presented in Table 4. By looking at the summary statistics (last five rows), one can observe that the $R^2$ computed for the cost function is rather high and identical across specifications, while the values of $R^2$ for the factor-share equations are not dissimilar except from the SQ model, where they are much lower (in particular for capital input). The poor ability of the SQ specification to fit the observed factor-shares is not surprising given that it assumes a strong separability between inputs and outputs. McElroy's (1977) $R^2$ can be used as a measure of the general goodness of fit for the NLSUR system. The results suggest that the fit is practically the same for the different functional forms and around 85%.

The first six rows present the estimates of first-order coefficients for output, average DRG weight and factor prices, which are all highly significant and show the expected sign. Since the results are similar across specifications, we will comment only on the estimated parameters for the ST model. Indeed, given that all regressors have been normalized to their sample mean value, and *OHC* as well as *Y* and *DRGW* are in natural logarithm in the ST specification ($\theta = \pi = 0$), the estimated first-order coefficients in Table 4 ($\alpha_Y$, $\alpha_{DRGW}$, $\beta_{MS}$, $\beta_D$ and $\beta_K$) can be directly interpreted as cost elasticities with respect to *Y*, *DRGW*, $P_{MS}$, $P_D$ and $P_K$ for the average LHU of the hospital industry.[6]

As for the output elasticity, the estimated coefficient is significantly lower than 1 (around 0.64), revealing the presence of remarkable scale economies (index of returns to scale = 1.57) that could be better exploited, for instance, by enlarging the average size of the hospitals managed by the LHU. On the *DRGW* side, it emerges a strong impact of the severity of illnesses on *OHC*, which is consistent with previous empirical literature on the cost structure of hospital services. Finally, as for the estimates of the cost-shares for medical staff, drugs and beds (corresponding to cost elasticities), they are very similar to their respective sample mean values (see $S_{MS}$, $S_D$ and $S_K$ in Table 3), thus confirming the general goodness of fit of the cost function model.

[4] More precisely, the GT model is obtained by setting $\phi = 0$ and $\tau = 1$, while the ST model requires the further restriction $\pi = 0$. The SQ model is obtained from the $PB_C$ specification by adding the restrictions $\delta_{Yr} = 0$ and $\delta_{DRGWr} = 0$ for all *r*.

[5] The log-quadratic input price structure can be easily constrained to be linearly homogeneous. To be consistent with cost minimization, (1) must satisfy symmetry ($\beta_{rl} = \beta_{lr}$ for all couples $r, l$) as well as the following properties: *a*) non-negative fitted costs; *b*) non-negative fitted marginal costs with respect to outputs; *c*) homogeneity of degree one of the cost function in input prices ($\Sigma_r\beta_r = 1$ and $\Sigma_l\beta_{rl} = 0$ for all *r*, as well as $\Sigma_r\delta_{Yr} = 0$ and $\Sigma_r\delta_{DRGWr} = 0$); *d*) non-decreasing fitted costs in input prices; *e*) concavity of the cost function in input prices.

[6] The *average* LHU (the point of normalization) corresponds to a hypothetical LHU operating at an average level of production and degree of complexity and facing average input prices. In the $PB_G$, $PB_C$, SQ and GT specifications the computation of such cost elasticities is more cumbersome; the results are available from the authors on request.