Diversification strategies and scope economies: Evidence from a sample of Italian regional bus transport providers

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Diversification strategies and scope economies: Evidence from a sample of Italian regional bus transport providers

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Abstract

A growing number of local public transport (LPT) companies diversify their production lines by providing a large set of services. We investigate the cost structure of a sample of LPT companies operating in Italy and assess the presence and the magnitude of scope economies. We split the whole sample of firms according to the diversification strategy: private firms, mainly diversifying in competitive transport-related services and public firms providing non-transport services in regulated markets. Scope economies appear sizeable for both groups but higher for firms pursuing a transport related strategy, suggesting it should be preferable to the multi-utility development pursued by public LPT firms.

Keywords: cost function, scope economies, transport companies

JEL: L25, L33, L50, L92

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1. INTRODUCTION

Only few papers analyse scope economies in the local public transport (LPT) industry where a growing number of companies diversify their production lines by providing a large set of services.

Our aim is twofold. On one side we evaluate the existence and dimension of scope economies for a set of firms operating in the local public transport industry, on the other side, we compare different diversification strategies.
In particular we assess whether horizontal diversification in industries or sub-industries close to the core transport activity ensures higher cost savings than horizontal diversification in non-related sectors. To sum up, from a social point of view, is the horizontal diversification of multi-utilities in regulated sectors justified? The analysis aims at better understanding the economic justification for such managerial choices and the presence of actual cost savings from the diversification in competitive *versus* regulated markets. The paper tries to fill the gap between research on scope economies in multi-utility firms and research on scope economies within local transport industry.

We use data from a sample of Italian bus companies observed over the period 1998-2004, that diversify their core activities supplying transport related services and / or non-transport services. The sample is also characterized by different ownership structures coupled with diversification strategies. Private firms mainly supply services highly related to the core business (e.g. bus renting and coaching activities), while publicly owned companies (mainly municipal firms) offer a large set of products, ranging from car park management to waste disposal, water and sewage treatment and gas and electricity distribution. In particular, while private firms mainly diversify in transport related competitive markets, public companies are usually active in regulated sectors unrelated to transport.

Our strategy is to estimate a cost function, using different model specifications. Many authors indicated the unreliable results from the standard translog specification when the main object is the analysis of scope economies and cost complementarities. Findings from the standard translog and the generalized (Box-Cox) translog function model are compared to those from the separable quadratic and the composite cost function introduced by Pulley and Braunstein (1992) that appear to be more suitable for studying the cost properties of multi- product firms.

Our results show that, for all functional forms, diversification economies are sizeable for both groups; however a diversification strategy close to the core business, generally practised by private firms, appears to allow for higher cost savings, suggesting this kind of strategy should be preferable to the multi-utility development pursued by public LPT firms.
Next section briefly reviews the empirical literature on scope economies and on functional choice for a cost model. Section 3 gives details on the different cost specifications that are estimated, while section 4 describes the dataset. Section 5 presents the main estimation results and a discussion on the economies of scope and size is given in section 6. Section 7 concludes.

2. LITERATURE REVIEW

Our perspective does not completely coincide either with the research on scope economies in multi-utilities, or the studies on scope economies within the local public transport, but these two strands of research are somehow the boundaries within which our work develops, so that we briefly review some of them.

Multi-utilities are the object of some ongoing policy reforms. Recent decisions by the European Union require the functional unbundling for vertical integrated utilities. Horizontal unbundling, on the contrary, obtains less attention as there is no clear-cut evidence on its anti-competitive effects. Among the others, Calzolari and Scarpa (2007) show that economies of scope may justify, from a social point of view, the horizontal diversification of multi-utilities in unregulated sectors. Some empirical investigations find support to the presence of scope economies for multi-utility firms (Fraquelli et al., 2004, Farsi et al., 2007b).

A scant number of papers consider scope economies in the public transport industry.

Viton (1992) considers urban transport companies supplying their services in six modes (motor bus, street cars, rapid rail, etc.) and the presence of scope and scale economies is uncovered. Similarly Colburn and Talley (1992) analyse a four modes urban company and find only limited cost complementarities. Viton (1993), by estimating a quadratic cost frontier for bus companies operating in the San Francisco bay area, evaluates the cost savings deriving from the merger of the seven companies in the sample. Cost savings depend on the modes being offered and on the number of merging firms, with benefits decreasing as the number of integrated companies increases.

Farsi et al. (2007a) study a sample of Swiss companies supplying urban services using three modes: trolley bus, motor bus and tramway systems. They detect global scope economies for multi-modal operators from the estimation of a quadratic cost function.

Many studies have considered the issue of the choice of the functional form for a cost model when the main purpose is to quantify the existence of scope economies from the simultaneous provision of different outputs. In general there seems to be a trade off among flexible functional forms satisfying all regularity conditions required for a cost function to be an adequate representation of the production technology (concave in input prices and non decreasing in input prices and outputs) and the dimension of the region over which such regularity conditions are fulfilled. Roller (1990) emphasizes that “this ‘regular’ region may be too small to be able to model demanding cost concepts such as economies of scope and subadditivity”. The most popular flexible functional forms, such as the standard translog model (see Christensen et al., 1971), have a degenerate behaviour in the region which is relevant for the derivation of scope economies and subadditivity measures (in general zero outputs levels) even if they satisfy the regularity conditions for a larger set of points (see Diewert, 1974 and Diewert and Wales, 1987).

Pulley and Braunstein (1992) and Pulley and Humphrey (1993) introduce the composite specification that unlike the translog model is defined in the neighbourhood of zero output levels and allows for the estimation of scope economies. McKillop et al. (1996), McKenzie and Small (1997), Bloch et al. (2001), Fraquelli et al. (2004), Piacenza and Vannoni (2004) and Fraquelli et al. (2005) all adopted the composite specification as their preferred model for the derivation of scope economies in different industries (ranging from the banking sector to the public utilities).

3. THE COST FUNCTION MODEL

Our aim is to study the cost structure of a sample of transport companies operating in the administrative region of Piedmont, in Northern Italy. In particular we are going to estimate a multi-output cost function since firms may provide a large set of services.

A stochastic cost function can be written as:

$$C_{ft} = C(\mathbf{y}_{ft}, \mathbf{p}_{ft}; \theta) + v_f + u_{ft}$$

where C_{ft} is total cost for firm $f = 1, \dots, F$, at time $t = 1, \dots T$, $\mathbf{y}_{ft}$ is the vector of outputs for firm f at time t, $\mathbf{p}_{ft}$ is the vector of input prices, θ is the vector of unknown parameters to be estimated, v_f is the firm specific time invariant error term, while u_{ft} is the remainder stochastic error term that varies over time and across companies.

Given the panel structure of the data, we are going to assume the absence of correlation among the individual specific effects v_f and the included regressors, i.e. $E(v_f \mid \mathbf{y}_{ft}, \mathbf{p}_{ft}) = 0$. This assumption ensures the consistency of the pooled nonlinear estimation procedure while panel robust standard errors, that take into account the likely correlation among errors for the same individual, should guarantee robust inference.

When dealing with nonlinear functional forms, the estimation of fixed effects or random effects models is not straightforward (see Cameron and Trivedi, 2005, chapter 23 for a survey) and solutions are mainly case specific. At the same time including a large set of firm specific dummy variables may lead to inconsistent estimates as the incidental problem arises (see Lancaster, 2000). Our choice of a pooled model is justified by the lower computational burden and the unreliable estimates that were obtained when trying to estimate a model where all individual dummy variables are included.

We present results for a three outputs cost model and section 4 gives details on the dataset construction.

We compare estimates from four different cost specifications. Baumol et al. (1982) recommend a quadratic output structure when examining scope economies because this form allows for the direct handling of zero outputs, without any need for substitutions or transformations as in the translog models.

We estimate a composite and a separable quadratic cost specification that have a quadratic structure in outputs and a log-quadratic structure in input prices, but also a standard translog and a generalized translog model.

The composite specification that we consider has the following form[1] (see Carroll and Rupert, 1984, 1988 and Pulley and Braunstein, 1992 for more details):

$$\ln(C) = \ln\left(\alpha_0 + \sum_i \alpha_i y_i + \frac{1}{2}\sum_i \sum_j \alpha_{ij} y_i y_j + \sum_i \sum_r \alpha_{ir} y_i \ln p_r + \gamma_1 Trend + \gamma_2 Trend^2 + \lambda\, Dummy\right) +$$
$$\left[\sum_r \beta_r \ln p_r + \frac{1}{2}\sum_r \sum_q \beta_{rq} \ln p_r \ln p_q\right] = \ln[h(\mathbf{y},\mathbf{p})] + f(\mathbf{p}) \tag{1}$$

where C is the total cost, y_i is output i, $i= T, TR, NT$, for transport, transport related and non-transport services respectively; p_r is the price for input $r=L, M, K$, for labour, material and capital respectively, while *Trend* and $Trend^2$ are a linear and a squared time trend respectively. *Dummy* stands for additional controls that we include in some specifications.

By applying the Shephard's Lemma, the associated input share equation is:

$$S_r = \frac{x_r p_r}{C} = \frac{\partial \ln(C)}{\partial \ln p_r} = \left[\beta_r + \sum_q \beta_{rq} \ln p_q\right] + \left(\sum_i \alpha_{ir} y_i\right) \cdot$$
$$\left(\alpha_0 + \sum_i \alpha_i y_i + \frac{1}{2}\sum_i \sum_j \alpha_{ij} y_j y_i + \sum_i \sum_r \alpha_{ir} y_i \ln p_r + \gamma_1 Trend + \gamma_2 Trend^2\right)^{-1} \cdot \tag{2}$$

where x_r is the derived demand for input r ($x_r=\partial C/\partial p_r$).

The separable quadratic model only differs from the composite specification in the assumed restriction that $\alpha_{ir} = 0$ for all i and r.

[1]In the following formulas we omit firm and time subscripts for notational brevity.

The generalized translog function is:

$$\ln(C) = \alpha_0 + \sum_i \alpha_i y_i^{(\pi)} + \frac{1}{2}\sum_i \sum_j \alpha_{ij} y_i^{(\pi)} y_j^{(\pi)} + \sum_i \sum_r \alpha_{ir} y_i^{(\pi)} \ln p_r +$$
$$\sum {}_r \beta_r \ln p_r + \frac{1}{2}\sum_r \sum_q \beta_{rq} \ln p_r \ln p_q + \gamma_1 Trend + \gamma_2 Trend^2 \qquad (3)$$

where $y_i^{(\pi)}$ is the Box – Cox (1964) transformation of the output measure i:

$$y_i^{(\pi)} = (y_i^{\pi} - 1)/\pi \qquad if \qquad \pi \neq 0$$
$$= \ln(y_i) \qquad if \qquad \pi = 0$$

The standard translog specification follows from the imposition of the restriction $\pi = 0$ in equation (2).

The input share equation associated to the generalized translog specification is:

$$S_r = \frac{x_r p_r}{C} = \frac{\partial \ln(C)}{\partial \ln p_r} = \sum_i \alpha_{ir} y_i^{(\pi)} + \beta_r + \sum_q \beta_{rq} \ln p_q \qquad (4)$$

Global economies of scope can be computed starting from the estimated cost functions as the difference among the sum of the costs associated to the disjoint productions and the total cost from the joint production. In the case of m outputs, global scope economies are given by:

$$SCOPE = [C(y_1,0,\ldots,0;\bar{\mathbf{p}}) + C(0,y_2,\ldots,0;\bar{\mathbf{p}}) + \ldots$$
$$+ C(0,0,\ldots,y_m;\bar{\mathbf{p}}) - C(y_1,y_2,\ldots,y_m;\bar{\mathbf{p}})] / C(y_1,y_2,\ldots,y_m;\bar{\mathbf{p}})$$

where C is the total cost, y_i is output i and $\mathbf{p}$ is the vector of input prices that are kept constant, usually at their sample median or mean level. Scope economies are detected if the value of *SCOPE*>0, while diseconomies arise if *SCOPE*<0.

It is also possible to compute product specific scope economies when more than two outputs are simultaneously produced:

$$SCOPE_i = [C(0,0,\ldots,0,y_i,0,\ldots,0;\bar{\mathbf{p}}) + C(y_1,y_2,\ldots,y_{i-1},0,y_{i+1}\ldots,y_m;\bar{\mathbf{p}}) -$$
$$C(y_1,y_2,\ldots,y_m;\bar{\mathbf{p}})] / C(y_1,y_2,\ldots,y_m;\bar{\mathbf{p}})$$

where the cost of producing product *i* only (first term in the formula of $SCOPE_i$) is summed to the production cost associated to all the other outputs (second term in the formula) and then compared to the total joint production cost. If $SCOPE_i > 0$, it follows that there are cost savings from the joint production of product *i* together with all the other goods.

Finally we can calculate scope economies for different pairs of products:

$$SCOPE_{ij} = [C(0,\ldots,0,y_i,0,\ldots,0;\bar{\mathbf{p}}) + C(0,\ldots,0,y_j,0,\ldots,0;\bar{\mathbf{p}}) - C(0,\ldots,0,y_i,0,\ldots,0,y_j,0,\ldots,0;\bar{\mathbf{p}})] / C(0,\ldots,0,y_i,0,\ldots,0,y_j,0,\ldots,0;\bar{\mathbf{p}})$$

for products *i* and *j*, with $i \neq j$, $SCOPE_{ij} > 0$ indicates the presence of scope economies from the joint production of the two goods, given the estimated cost structure.

We are also able to evaluate the magnitude of scale economies (*SCALE*):

$$SCALE = \left(\sum_i \frac{\partial \ln(C)}{\partial \ln(y_i)} \right)^{-1}$$

where the derivatives need to be interpreted as cost elasticities with respect to the *i*th output.

Economies of scale are present when *SCALE* is greater than one, while diseconomies of scale are found if *SCALE* is smaller than one. Neither economies nor diseconomies exist if *SCALE* is equal to one.

4. INDUSTRY AND DATA DESCRIPTION

Data come from two sources: the database owned by the administrative region of Piedmont, which yearly collects information on transport services supplied by the companies of the area and the official accounting reports of the firms.

The regional database reports data on total costs, input costs and outputs for all the companies supplying local public transport services. We complement these data, providing information on transport activities only, with companies' annual reports. The aim is to obtain a comprehensive picture of the whole set of services and outputs that transport companies offer.

Our final sample is an unbalanced panel of 40 firms whose annual observations cover the period 1998-2004.

We define three broad outputs: subsidized local public transport services, non-subsidized transport related activities and non-transport services.

Local public transport comprises urban and intercity transport connections that represent the main business for all the firms in our sample. Non-subsidized transport related activities denote coach renting and tourist travelling.

Non-transport services mainly relate to regulated markets. They represent a broad and varied set of productions mainly consisting of parking areas management. For two firms the activity consists of waste disposal and water treatment and for one firm it encompasses gas and electricity distribution. Information on such services come from the companies' financial statements.

The output quantities for transport services (Y_T) are given by vehicle-kilometres covered over the urban network and the intercity connections. Similarly the output quantities for transport related activities (Y_{TR}) are the vehicle-kilometres, equal to the product of the number of vehicles by the total number of kilometres covered over the year for coach renting and tourist travel organization.

The output for the non-transport productions (Y_{NT}) is obtained as the ratio of total revenues associated to such products to the consumer price index for housing, water, electricity and fuels[2].

The choice of such magnitude was mainly motivated by measurement difficulties. Many outputs definition have been adopted in transport studies, usually grouped into demand oriented measures (such as passengers-kilometres) and supply oriented outputs (like vehicle- kilometres or seat- kilometres). More ambiguous is the definition of a physical measure for the other two outputs. Transport related activities can in principle be measured by vehicle-kilometres or seat-kilometres as for transport services, however we expect these quantities may underestimate the actual activity of the sampled companies as some companies may have different accounting practices, deciding to report e.g. the number of renting hours or other measures, not available to

[2] The source for price indexes is Istat, Italian Statistical Institute, www.istat.it. The consumption price index is town and province specific and we apply the appropriate price index according to the town and province where the company runs its business.

us. Even more demanding is the task for other non-transport services as they are a very heterogeneous category (car parks management, electricity and gas distribution, water and sewage treatment, waste disposal, etc.), and we were not able to disentangle the information on each single activity. Total revenues were finally selected as they were readily available while index prices should control for price effects. A similar approach was followed, among the others, by McKillop et al. (1996) in their study of giant Japanese banks, Cowie and Asenova (1999) for the assessment of cost inefficiencies in the British bus industry, Silk and Berndt (2004) for marketing firms and Asai (2006) for the broadcasting industry.

Total costs for a firm are given by total production costs as they are reported by the annual company profit and loss accounts.

Three inputs are considered: labour, materials and capital.

Labour price (p_L) is calculated dividing total labour costs as they appear in the profit and loss account, by the total number of employees of the company.

Total material costs are obtained from the corresponding company account item and include raw materials, consumption and maintenance goods' purchases, energy and fuel expenses. The price for this heterogeneous input is measured by the production price index for energy and gas, since most of the expenditures for materials are for energy and fuels.

Following Christensen and Jorgenson (1969), price for capital (p_K) is computed as:

$$p_k = \frac{PPI(IR + D)}{(1 - T)}$$

where PPI is the production price index for investment goods[3], IR is the yearly average long term prime lending interest rate as assessed by the Italian Banking Association [4] (ABI), while D is the depreciation rate and T is the corporate tax rate.

D is computed as the ratio of total depreciation expenses to book-valued fixed assets at the beginning of the period. T is obtained as total paid taxes divided by operating profits, as they appear in the financial statements. A similar approach for the derivation of capital and material prices is followed by Adams et al. (2004) and Asai (2006).

[3] Data source: Istat, Italian Statistical Institute, www.istat.it

[4] Data available from the Bank of Italy website, www.bancaditalia.it

Tables 1 and 2 report some descriptive statistics for the sample.

Firms are quite heterogeneous in their operating size: standard deviations for total operating costs and total revenues are quite high and the median is always smaller than the mean. Companies are asymmetrically distributed and few very large firms share the market with many small and medium sized LPT firms. The largest firms in the sample are publicly owned and table 2 splits the sample according to ownership. Apart from the size differences[5], it is interesting to note the different production lines for the two groups of firms considering the median output levels and the revenues' shares: while publicly owned firms, mainly municipal entities, are diversified in regulated markets, such as e.g. waste disposal, water and sewage treatment and gas and electricity distribution; private companies diversify their activities in competitive transport related unregulated sectors, such as bus renting, coaching activities and tourist services.

Differences across the firms in the sample and between public and private companies are less evident when we consider the inputs: labour and capital prices as well as labour and material costs shares on total costs are characterized by smaller standard deviations.

Before estimation, all variables are normalised by their sample median levels. Moreover in order to cope with the required regularity conditions for cost functions, a number of restrictions are imposed in all models. Symmetry is ensured by the imposition of the following equalities in all cost specifications (see equations (1) and (2)): $\alpha_{ij} = \alpha_{ji}$ and $\beta_{rk} = \beta_{kr}$. Linear homogeneity, requiring $\Sigma_r \alpha_{ir} = 0$ *for all i;* $\Sigma_r \beta_r = 1$ and $\Sigma_k \beta_{rk} = 0$ *for all k*, is obtained dividing both the dependent variable (total costs) and the labour and material prices by the capital price which does not directly appear in the estimated function. The other regularity conditions (non-negative marginal costs with respect to outputs, non decreasing costs in input prices and concavity of the cost function in input prices) are checked after estimation for all sample observations. In particular we need to check that fitted costs and fitted marginal costs with respect to outputs and input prices are non-negative and that the Hessian matrix of the cost function with respect to input prices is negative semi-definite[6].

[5] The largest firm in the dataset is GTT (Gruppo Torinese Trasporti), owned by the municipality of Turin.

5. ESTIMATION RESULTS

Table 3 presents the estimated parameters for the four specifications of the cost function: the standard translog, the generalized translog, the separable quadratic and the composite forms.

We simultaneously estimate the cost function and the corresponding input share equations (eq. (1) and (2) for the separable quadratic and the composite models; eq. (3) and (4) for the standard and generalized translog specifications) via a non-linear seemingly unrelated estimator. Since the three input cost share equations are linearly dependent, we drop the equation for capital price, obtaining a system of three equations for each specification. In order to control for the likely correlation among errors for the same firm, we present panel robust standard errors, that should guarantee robust inference.

The first order terms for outputs are positive and statistically significant in all specifications. The second order and the interaction coefficients for outputs are less precisely estimated, the only exception being the standard translog where all squared outputs are highly significant.

First order parameters for the labour price and material price are always precisely estimated. The coefficient for labour price differs across specifications, with larger magnitudes from the composite models.

The interpretation of the first order coefficients, however, differs across the models: while they represent estimates of cost elasticities (with respect to output and with respect to input prices respectively) in the translog specifications, they do not have straightforward interpretation in the separable quadratic and composite forms. We compute cost elasticities also for the last two specifications and we obtain similar magnitudes. The highest cost elasticity is found for transport outputs (0.54 under the standard translog specification, 0.63 under the generalized translog, 0.68 under the

[6] In the composite specification we obtain that: a) fitted costs are always non-negative; b) fitted labour and material shares are always non-negative, c) fitted marginal costs with respect to transport services are always non-negative, fitted marginal costs with respect to transport related output are negative for 77 observations, fitted marginal costs for non-transport services are negative for 26 observations; d) the Hessian matrix of the cost function with respect to input prices is always negative semi-definite, except for 14 observations.

About 60% of observations satisfy all regularity conditions under the preferred specification separable quadratic and 0.74 for the composite model), the smallest is for non-transport services (ranging from 0.03 for the separable quadratic, to 0.15 from the standard translog) and transport related activities are in between the two (in the interval 0.07-0.19, whose limits are obtained from the composite specification and the standard translog respectively).

Cost elasticities with respect to input prices are very similar to actual input shares (see table 1 for descriptive statistics on labour and matreial shares). They range between 0.45 (from the standard translog) and 0.52 (from the composite) for labour and between 0.18 (composite specification) and 0.19 (standard translog) for material.

The time trend parameter is always negative and significant in the last three specifications, indicating cost reductions over time. The positive second order trend coefficient, however, indicates that such cost savings diminish over time.

Table 3 also shows a number of goodness-of-fit statistics. A set of likelihood ratio tests are reported, where the restrictions imposed by the standard translog model and the separable quadratic model are tested against the unrestricted generalized translog and composite specifications respectively. The generalized translog is always preferred to the standard translog model that imposes $\pi=0$. The π parameter is significant and particularly large (π=0.4), suggesting sizeable differences among the estimated economies of density and scope from the two models, with more reasonable magnitudes from the generalized translog (see McKillop et al., 1996).

The restrictions imposed by the separable quadratic model are rejected at the 5% level.

The translog and the quadratic specifications are non-nested models that cannot be directly tested, however larger log likelihood and lower Akaike and Schwarz information criteria for the separable quadratic and the composite models suggest a better statistical fit. We also perform a Vuong (1989) closeness test, which is a likelihood-ratio based test that allows us to compare the two non-nested models: the generalized translog and the composite specifications. The composite model seems to be preferred to the generalized translog specification as the statistics exceeds the quantile from the standard normal distribution at any significance level.

6. ECONOMIES OF SCOPE AND SIZE

Table 4 presents scope and density economies computed using all the estimated specifications. As expected results significantly vary across different cost function models.

Scope economies computations based on the standard translog specification are unreliable: they are extremely large and imprecisely estimated for any sample (whole, public firms or private firms sub-samples) and for any considered sample point (first, second or third quartile). The explanation can be found in the degenerate behaviour of such cost function when outputs are close to zero (see Roller, 1990).

The generalized translog, the separable quadratic and the composite specifications, on the contrary, provide comparable results.

Scope economies for the median firm in the sample range between 34% and 47% depending on the chosen cost function and they always are significantly different from zero.

Global scope economies for the median public firm range between -3.5% and 29% and significantly differ from zero only for the separable quadratic and composite models. Economies of scope for privately owned firms are always statistical significant and range between 31% and 46%. Global scope economies are generally lower when computations are based on the generalized translog model, while the largest estimates are from the separable quadratic function. The composite specification is in between the two.

Table 4 also reports the estimated global scope economies at the first and the third quartile points. Scope economies decrease with size, especially if the generalized translog cost function is adopted or the sub-sample of public firms is considered.

Table 4 finally shows scale economies. They are always significantly different from one (except for the standard translog specification) indicating the presence of economies of size: proportionally increasing the operating size (with respect to all outputs) lowers average costs.

Our preferred specification is the composite cost function and next tables present results based on this specification only. We already mentioned the unreliable and unstable results from the standard translog specification with respect to global scope economies, that make it inadequate for our purposes. The composite specification is preferred to the separable quadratic function on the basis of the likelihood ratio test that rejects the restrictions imposed by the separable quadratic model (i.e. the strong separability between inputs and outputs). We finally performed a Vuong test for the non-nested generalized translog and composite models. The test suggests the composite model to be preferred to the generalized translog.

Table 5 presents product specific scope economies and scope economies for couples of products.

Product specific scope economies (first three rows in table 5) give a measure of the cost savings associated to the joint production when compared to the production of one output only on one side and the remaining two products on the other. Results from the composite specification give evidence of product specific scope economies that are quite similar across different outputs and are always positive and sizeable (ranging from 16% to 18%).

Pair specific scope economies are also interesting, given the different production sets supplied by public and private firms. Public firms mainly provide transport and non-transport services and scope economies associated to this pair of outputs are always smaller, particularly for public firms (9% vs 16% for the whole sample and the subsample of private companies). Private firms, that are specialized in transport and transport related activities, have quite high scope economies from this pair of outputs (20% , while for the median public firm cost savings amount to 12%).

Differing global scope economies for the two groups of public and private firms might be the result of two effects: on one side the size effect; on the other side the effect of different diversification strategies. In general public firms are larger than private firms (see table 2) and they exhibit lower global scope economies as table 4 makes clear. Moreover public firms mainly diversify in regulated industries (non-transport services), while private firms in competitive markets (transport related activities) and we are interested in the sign and dimension of the scope economies deriving from the strategic choice of diversification. In order to disentangle these effects and to check the robustness of our results, table 6 reports some summary statistics about global scope economies computed for each observation in the sample (see Farsi et al., 2007b, for a similar approach). While computations from tables 4 and 5 are based on the construction of some "hypothetical" firms, characterized by a production set that alternatively coincides with the first, the second and the third quartiles for the three measures of output, in table 6 we estimate global scope economies at each actual sample point[7]. The distribution of global scope economies in the sample mimics the results from table 4. The median value is 30% in the whole sample, while in the sub-samples of public and private firms the median global scope economies are in the intervals 12% and 35% respectively. Estimates based on the sub-sample of public firms always display lower diversification economies.

Table 6 also shows global scope economies for different dimensional classes. In particular we identify four classes (small, medium-small, medium and large) according to the number of employees and we compute the median scope economies for each group of companies. Scope economies decrease with size and lower economies are found for public firms, in all classes.

We finally assess the robustness of our results to two issues: (i) differences in the cost structure of public and private firms; (ii) the definition of the output for non transport services. Table 7 shows results from the estimation of two composite models. In column (1) we report the base case model where we also include a dummy variable (dummy-public) that equals one for publicly owned firms and zero for private companies. Point estimates turn out to be very similar to those already discussed in section 5. The dummy for public firms is positive but not significantly different from zero, suggesting that the cost structure for the two sets of firms is very similar, at least in terms of the intercept of the cost function.

In the second column of table 7 we present the results from a composite specification where we drop the output measure for non transport services and introduce a dummy variable (dummy-non-transport) that takes value one if the firm in that year declared to supply unrelated services and zero otherwise. The main advantage with respect to our preferred specification is that we avoid the non physical measure of the output and can thus check for the robustness of our results. The main drawback is that we are not able to measure global scope economies with respect to the provision of the three outputs. Some coefficients lose precision (e.g. the transport related output) and the log-likelihood and the two information criteria suggest lower statistical fit for this model. The dummy for public firms is now positive and significant. Similarly the

[7]However input prices are always kept at the sample median level for all firms.

dummy for non transport services is positive and significantly different from zero. Once we control for ownership, producing unrelated services increases total costs. In the last two rows of table 7 we also compute global scope economies. Scope economies as computed from the first model are comparable to those from our preferred specification (29%). From the second model we can only compute scope economies between the the two included outputs and they amount to 37%. When the dummy for non transport services is set equal to one, scope economies increase to 42%. We argue that these magnitudes are not easily comparable to those obtained from a full three-output cost function, as some sort of model misspecification may be present. However some interesting findings can be highlighted. First, cost elasticities from the two-output model are very similar to those from the preferred specification, suggesting that these magnitudes are quite stable across specifications. Cost elasticity with respect to transport is statistically significant and equals 0.62 for the median firm in the sample (0.74 from the composite model in table 3) while cost elasticities with respect to related transport output is 0.06 (0.07 from the preferred specification) but not significant at conventional levels. Similarly cost elasticities with respect to input prices are in line with those from the three output model.

Second, scope economies as computed from the two output model should in principle be compared to the pair specific scope economies as presented in table 5. Cost savings from the joint production of transport outputs (subsidized and related) amount to 16% for the median firm in the sample, which is about a half of the diversification economies found from the two-output technology. We claim that our main finding could be interpreted as some lower bound in the possible cost savings from the joint production of transport and unrelated services.

On the whole, the evidence points to the presence of sizeable global scope economies for the median firm in the sample. Cost savings from the joint production reduce as the operation scale increases.

We split the whole sample of firms according to the diversification strategy and find that firms providing non-transport services in regulated markets (publicly owned companies) always display lower scope economies (and in some cases also diseconomies), for any considered sample point and for any cost specification. The two groups of firms differ both in the operation scales and in the diversification strategies. Privately owned firms are small and mainly diversify in non-subsidized transport related services, while publicly owned firms operate at a larger scale and provide services in regulated markets. In an attempt to isolate the effect of the diversification strategy, we compute scope economies at each actual sample point and find that firms diversifying in non-transport activities are characterized by lower cost savings that are close to zero for the largest firms.

7. CONCLUSIONS

This study gives evidence on the presence of cost savings from the joint production of transport services, transport related activities and other non-transport productions using different functional forms.

As expected, scope and density economies differ according to the chosen cost model, but they are always present. Global scope economies, for the median firm in the sample, amount to 34% under the preferred composite specification and costs savings mainly result from the fixed costs component.

We split the whole sample of firms according to diversification strategy: private firms, mainly diversifying in competitive transport related services and public firms providing non-transport services in regulated unrelated markets. Regardless of the functional form and the method used, scope economies appear sizeable for both groups but higher for firms diversifying in industries or sub-industries that are close to the core transport activity.

As scope economies appear to be decreasing with firm's size we calculate them at each sample point, so as to compare homogeneous dimensional classes, in order to exclude the possibility that public LPT firms' lower scope economies should merely depend on their larger dimension: results remain unaltered.

Applying the usual caveat, the analysis, then, suggests that, from a social point of view, horizontal diversification of LPT firms in non related activities should be fostered with caution, as it ensures smaller scope economies as compared to transport related diversification.

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TABLE 1: Descriptive statistics for the whole sample. Unbalanced panel: 40 firms over the period 1998-2004, 184 observations.

	Mean	Std. Dev.	Median
Total operating costs (th. Euro)	8,958.98	33,294.42	3,416.91
Total revenues (th Euro)	9,290.93	34,572.25	3,443.30
Share of total revenues from transport (%)	56.07	25.74	56.86
Share of total revenues from non-transport (%)	17.95	28.50	4.41
Share of total revenues from transport related (%)	25.98	21.85	23.98
Y_T (vehicle-kilometres)	2,313,250	7,225,454	990,625
Y_{NT} (revenues/CPI)	20.21	58.65	0.95
Y_{TR} (vehicle-kilometres)	466,197.7	552,469.9	307,822
Labour price p_L (th. Euro)	35.68	32.65	33.86
Material price p_M (price index)	119.70	12.84	124.10
Capital price p_K	34.40	20.90	28.02
Labour share	0.45	0.10	0.44
Material share	0.18	0.08	0.17
Total cost of personnel (th. Euro)	4,423.29	17,786.84	1,436.71
Number of employees	134.44	539.38	40.50
Total cost of materials (th. Euro)	1,421.05	3,690.66	626.81
Dummy-public	0.266	0.443	0
Dummy-non-transport	0.810	0.394	1

Notes: See the text for the definition of the output measures y_T, y_{NT}, y_{TR} and the input prices p_L, p_M, p_K

TABLE 2: Descriptive statistics for the samples of publicly and privately owned companies.

	11 public firms, 49 obs.			29 private firms, 135 obs.		
	Mean	Std. dev.	Median	Mean	Std. dev.	Median
Total operating costs (th. Euro)	22,725.86	62,704.37	10,013.16	3,962.12	3,315.54	2,422.29
Total revenues (th Euro)	23,332.88	65,183.99	9,718.74	4,194.22	3,467.14	2,651.03
Share of total revenues from transport (%)	48.20	33.75	52.13	58.93	21.59	57.88
Share of total revenues from non-transport (%)	44.82	37.80	34.53	8.20	15.42	1.51
Share of total revenues from transport related (%)	6.98	12.67	3.45	32.87	20.36	32.75
Y_T (vehicle-kilometres)	4,517,011	1.36e+07	1,404,906	1,513,367	1,626,780	989,512
Y_{NT} (revenues/CPI)	67.43	99.38	13.65	3.07	6.95	0.47
Y_{TR} (vehicle-kilometres)	84,817.25	140,354.3	0	604,624.7	580,762.9	479,697
Labour price p_L (th. Euro)	42.49	61.69	33.93	33.21	8.31	33.75
Material price p_M (price index)	123.38	9.92	124.30	118.36	13.53	124.10
Capital price p_K	30.05	23.42	26.18	35.98	19.77	29.19
Labour share	0.50	0.13	0.53	0.43	0.08	0.42
Material share	0.19	0.13	0.14	0.18	0.05	0.18
Total cost of personnel (th. Euro)	11,534.70	33,574.90	3,555.44	1,842.11	1,747.94	1,064.00
Number of employees	351.12	1,017.88	94.00	55.79	52.71	34.00
Total cost of materials (th. Euro)	3,311.56	6,777.43	1,165.80	734.87	648.08	471.87

Notes: See the text for the definition of the output measure y_T, y_{NT}, , y_{TR} and the input prices p_L, p_M, p_K

TABLE 3: Estimation results. Dependent variable: natural logarithm of total operating costs, normalized by the capital price. Cluster robust standard errors in parenthesis, 184 observations.

Dependent variables	*Standard Translog*	*Generalized Translog*	*Separable quadratic*	*Composite*
Y_T	0.540***	0.627***	1856.899***	2043.259***
	(0.08)	(0.06)	(216.33)	(203.69)
Y_{NT}	0.145***	0.057***	78.021***	119.828***
	(0.03)	(0.02)	(16.41)	(18.90)
Y_{TR}	0.194***	0.115**	184.559*	193.919**
	(0.06)	(0.04)	(111.60)	(92.46)
Y_T^2	0.277***	0.001	86.334	81.773
	(0.07)	(0.04)	(73.64)	(65.40)
Y_{NT}^2	0.021***	0.009	0.608**	-0.195
	(0.01)	(0.01)	(0.29)	(0.20)
Y_{TR}^2	0.033***	0.118**	76.655**	87.872**
	(0.01)	(0.04)	(27.52)	(30.43)
$Y_T\ Y_{NT}$	-0.011	-0.046	-2.629	-4.947
	(0.02)	(0.03)	(11.30)	(9.33)
$Y_T\ Y_{TR}$	0.026	-0.074	-82.519	-167.867
	(0.02)	(0.06)	(118.12)	(107.94)
$Y_{TR}\ Y_{NT}$	-0.007	0.005	-17.022	-22.695**
	(0.01)	(0.02)	(17.43)	(11.16)
$Y_T\ lnp_L$	0.015	0.016		-469.886***
	(0.02)	(0.01)		(120.20)
$Y_{NT}\ lnp_L$	-0.001	-0.001		-34.098***
	(0.00)	(0.00)		(8.74)
$Y_{TR}\ lnp_L$	-0.002	-0.003		-120.787***
	(0.00)	(0.01)		(20.91)
$Y_T\ lnp_M$	-0.005	-0.010		-47.771
	(0.01)	(0.01)		(155.82)
$Y_{NT}\ lnp_M$	0.001	0.002		4.270
	(0.00)	(0.00)		(7.91)
$Y_{TR}\ lnp_M$	0.000	0.006		13.024
	(0.00)	(0.01)		(18.09)
Trend	-0.063	-0.430**	-826.619**	-834.657***
	(0.35)	(0.19)	(261.08)	(214.10)
Trend^2	0.010	0.287	538.526**	611.399***
	(0.35)	(0.19)	(228.83)	(178.23)
lnp_L	0.450***	0.451***	0.455***	0.746***
	(0.01)	(0.01)	(0.02)	(0.05)
lnp_L^2	-0.002	0.000	-0.006	0.084
	(0.04)	(0.03)	(0.03)	(0.05)
lnp_M	0.188***	0.185***	0.190***	0.190**
	(0.01)	(0.01)	(0.01)	(0.07)
lnp_M^2	-0.006	0.035*	0.022	0.018
	(0.02)	(0.02)	(0.02)	(0.02)
$lnp_L\ lnp_M$	0.022	0.003	0.022	0.016
	(0.02)	(0.02)	(0.02)	(0.04)
Constant	7.804***	7.903***	631.380**	418.375**
	(0.17)	(0.07)	(215.28)	(191.20)
π		0.443***		
		(0.09)		
Cost funct. R^2adj	0.99	0.99	0.99	0.99
Lab. share eq. R^2adj	0.96	0.96	0.95	0.97

Mat. share eq. R^2adj	0.86	0.87	0.86	0.87
LogL	295.07	370.93	402.21	427.84
AIC	-544.13	-693.86	-770.42	-809.68
BIC	-470.19	-616.70	-715.76	-735.73
LR test [p-value]	151.73 [0.0] 1 d.f.		51.26 [0.00] 6 d.f.	
Vuong Test Statistics		118.43		

Notes:

- All estimates performed by the routine nlsur for Stata 10.1, using an iterative Feasible Generalized NLS estimator.
- The subscripts for the output variables are *T* for transport services, *TR* for transport related activities and *NT* for non-transport services. The subscripts for the input prices are *L* for labour and *M* for other variable inputs (i.e. raw materials and fuels).
- In the estimation of the standard translog specification, zero output levels are substituted by the value 0.00001.
- Standard errors are robust to heteroschedasticity of unknown form and to the likely presence of intra cluster correlation. Each cluster is represented by a different firm (40 clusters - firms in all specifications).
- R^2adj is the centered adjusted R^2, LogL is the value of the log-likelihood function, assuming errors are i.i.d. Normal. AIC and BIC are the Akaike and Schwarz Bayesian information criteria respectively
- LR test is the likelihood ratio test over the restricted specifications. The standard translog specification is the restricted model for the generalized translog (H_0: π=0), while the separable quadratic model is the restricted specification for the composite model (H_0: all interactions among input prices and output measures are zero).
- Vuong test statistics is the Vuong (1989) closeness test. The null hypothesis is that the composite model and the generalized translog model are the same. The null is rejected at any significance level in favor of the composite model.
- Significance levels: * 10%; ** 5%; *** 1%.

TABLE 4: Global scope and density economies. Asymptotic standard errors in parenthesis.

	Std. translog	*Generalized translog*	*Separable quadratic*	*Composite*
Global Scope Economies:				
Whole sample				
1st quartile	2.69e+09	0.599***	0.871***	0.635***
	(1.58e+10)	*(0.123)*	*(0.194)*	*(0.216)*
Median	3.23e+09	0.353**	0.472***	0.338***
	(1.82e+10)	*(0.196)*	*(0.136)*	*(0.126)*
3rd quartile	2.33e+09	0.022	0.306***	0.258***
	(1.30e+10)	*(0.194)*	*(0.112)*	*(0.084)*
Public firms sample				
1st quartile	3.18e+09	0.358***	0.753***	0.479***
	(1.81e+10)	*(0.143)*	*(0.170)*	*(0.166)*
Median	2.30e+09	-0.035	0.286***	0.176***
	(1.30e+10)	*(0.150)*	*(0.098)*	*(0.077)*
3rd quartile	4.12e+09	-0.416	0.097	0.110
	(2.28e+10)	*(0.268)*	*(0.109)*	*(0.096)*
Private firms sample				
1st quartile	2.30e+09	0.703***	0.813***	0.597***
	(1.35e+10)	*(0.201)*	*(0.197)*	*(0.212)*
Median	2.73e+09	0.313**	0.464***	0.346***
	(1.55e+10)	*(0.194)*	*(0.133)*	*(0.125)*
3rd quartile	2.09e+09	0.062	0.332***	0.284***
	(1.18e+10)	*(0.178)*	*(0.105)*	*(0.093)*
Global scale economies	1.137***	1.251***	1.275***	1.185***
	(0.118)	*(0.123)*	*(0.100)*	*(0.082)*
P-value of the test on unit scale economies	*[0.12]*	*[0.02]*	*[0.00]*	*[0.01]*

Notes: Global scope economies are evaluated for an hypothetical firm with the first quartile, median and third quartile level of each output in the whole sample and in the sub-samples of public and private firms respectively. Input prices are always kept at the sample median value. In the computation of scope economies for the standard translog model, zero output levels are substituted with 0.000001. Scale economies are computed for the median firm in the sample.

TABLE 5: Estimated product specific scope economies: composite specifications. Asymptotic standard errors in parenthesis.

	Whole sample	Public firms	Private firms
SCOPE $_{T}$	0.183***	0.093**	0.195***
	(0.062)	*(0.044)*	*(0.063)*
SCOPE $_{NT}$	0.156***	0.093**	0.151***
	(0.066)	*(0.044)*	*(0.065)*
SCOPE $_{TR}$	0.186***	0.083***	0.197***
	(0.062)	*(0.036)*	*(0.063)*
SCOPE $_{T,\ NT}$	0.161***	0.093**	0.164***
	(0.066)	*(0.044)*	*(0.068)*
SCOPE $_{T,\ TR}$	0.189***	0.123***	0.198***
	(0.064)	*(0.053)*	*(0.064)*

Notes: All magnitudes are evaluated for the hypothetical median firm in the sample, scope economies for public and private firms are evaluated for the hypothetical median public and private firm respectively. Input prices are always kept at the sample median value.

TABLE 6: Median value of global scope economies estimated for each actual firm. Distribution by dimensional classes.

	Whole sample	Public firms	Private firms
All firms	0.306	0.127	0.346
Small firms	0.420	0.342	0.438
Medium-Small firms	0.233	0.083	0.287
Medium firms	0.151	0.141	0.175
Large firms	0.076	0.076	-

The four dimensional classes are defined according to the number of employees: small (<50 empl.), medium-small (50-150 empl.); medium (150-250 empl.); large (>250 empl.)

TABLE 7: Estimation results for composite specifications. Dependent variable: natural logarithm of total operating costs, normalized by the capital price. Cluster robust standard errors in parenthesis, 184 observations

Dependent variables	(1)	(2)
Y_T	1944.682***	1609.104***
	(173.55)	(269.39)
Y_{NT}	109.187***	
	(14.16)	
Y_{TR}	224.427**	41.263
	(80.29)	(200.15)
Y_T^2	77.398	175.365**
	(53.60)	(79.98)
Y_{NT}^2	-0.085	
	(0.16)	
Y_{TR}^2	69.210**	174.547**
	(29.35)	(84.66)
$Y_T\ Y_{NT}$	-7.370	
	(7.62)	
$Y_T\ Y_{TR}$	-112.907	-61.806
	(98.22)	(210.41)
$Y_{TR}\ Y_{NT}$	-12.166	
	(11.88)	
$Y_T\ lnp_L$	-603.117***	-64.057
	(164.94)	(130.67)
$Y_{NT}\ lnp_L$	-41.177***	
	(10.94)	
$Y_{TR}\ lnp_L$	-137.829***	-53.770**
	(25.93)	(26.53)
$Y_T\ lnp_M$	-66.476	-76.249
	(152.16)	(69.77)
$Y_{NT}\ lnp_M$	3.045	
	(8.31)	
$Y_{TR}\ lnp_M$	9.075	7.153
	(18.97)	(13.02)
Trend	-686.790**	-2957.180**
	(233.73)	(1068.74)
Trend^2	489.531**	2174.921**
	(194.85)	(802.44)
lnp_L	0.817***	0.506***
	(0.08)	(0.06)

lnp_L^2	0.123**	-0.021
	(0.06)	(0.03)
lnp_M	0.200**	0.206***
	(0.07)	(0.03)
lnp_M^2	0.017	-0.019
	(0.02)	(0.02)
$lnp_L\, lnp_M$	0.021	0.047**
	(0.04)	(0.02)
Dummy - Public	446.120	4979.991**
	(328.69)	(2411.07)
Dummy - Non - Transport		205.024**
		(71.67)
Constant	346.218**	1803.321**
	(175.21)	(732.03)
Cost funct. R^2adj	0.999	0.996
Lab. share eq. R^2adj	0.971	0.959
Mat. share eq. R^2adj	0.871	0.864
LogL	432.94	285.54
AIC	-817.88	-533.08
BIC	-740.72	-472.00
Global scope economies	0.288**	0.374***
	(0.123)	(0.133)

Significance levels: * 10%; ** 5%; *** 1%