Privatisation, regulation and productivity
in the Italian motorway industry*

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Abstract

The Italian highway sector has undergone an institutional and regulatory reform through the last decade, characterised by changes in the proprietary asset and a new price cap framework. To look at the effect of the reforms on firms’ performance, we use information on all the 20 Italian concessionaires over the 1992-2003 period and 1) estimate the technical progress in the industry, thereby providing a reference value for the X factor in the price cap formula; 2) assess the relative productivity of private vs. public concessionaires; 3) evaluate whether price cap regulation has induced firms to use resources efficiently, 4) determine the possible effect of the inclusion of the quality index in the price cap formula.

The introduction of a price cap regime does not increase firms’ productivity whereas a sharp increase in maintenance costs is recorded, arguably due to a quality indicator in the price cap formula. Furthermore, firms appear to have gained from the privatisation process and from a technical progress occurred in the period. These findings and the sharp increase in profits shown by concessionaires suggest the need for a reconsideration of the regulatory framework and for an improvement in the regulator’s methodology for setting the X factor.

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1 Introduction

Since the beginning of the last decade, the institutional and regulatory set-up of the Italian motorway sector has undergone in-depth reform. We have firstly observed changes in the proprietary assets with a relevant transfer of control from public to private hands and, then, the adoption of new national regulation of the motorway concessionaires where the price cap regulation (PC regulation) has been introduced.

Both the design for the regulatory framework and its applications has recently raised some concerns. These are related mostly to the sharp increase in profits for the firms operating in the industry which can be observed since the introduction of the new regulatory framework. Rather surprisingly, the motorway industry has not studied extensively in recent years, not even in the occasion of the its regulatory reform. Therefore, there is no too much evidence on which to base the judgement one can make on the history of the regulatory intervention in the industry.

The aim of this paper is to start filling these gap. To this end, a unique dataset has been collected via inspection of all the 20 Italian concessionaires’ official reports and of the AISCAT publications (the concessionaires’ association). The database contains, over the 1992-2003 period, the following kind of variables: firms’ financial indicators (such as costs, revenues, inputs), characteristics of the sections served (such as length, stonework, mountain sections, accident rates, total number of kilometers traveled) and concessionaires’ institutional characteristics (ownership, i.e. private vs. public ownership, and type of regulation, i.e. price cap vs. rate of return).

This dataset has been used to estimate a total cost function with flexible functional form (translog) augmented with hedonic variables reflecting characteristics of the sections served, ownership and regulation dummy variables and a temporal
trend. This research strategy has enabled us to: 1) estimate the technical progress occurred in the highway industry, thereby providing a reference value for setting the X factor in the price cap formula; 2) evaluate whether the (change of) ownership of the concessionaries has had an effect on their productivity; 3) evaluate whether the introduction of the price cap regulation has had an effect on their efficient use of resources; 4) consider the possible effects of the inclusion of the quality index in the price cap formula.

Our results show significant technical progress, thereby suggesting the use of a high correction factor in the price cap formula. As for the impact of institutional factors on productivity, different results emerge. On the one hand, the privatization process seems to have brought about a better use of resources, as firms under private ownership appear to be more productive than those under public ownership. On the other hand, the replacement of the cost plus regulation with the one based on price cap does not seem to have induced firms to cost saving behaviors. In particular, concessionaires have considerably increased their maintenance costs; their behaviour seems to be motivated by the (possible perverse) incentive provided in this direction by the introduction of a quality index in the price cap formula.

The paper is organized as follows. The next section describes the regulation reform that has occurred in the Italian highway sector, whereas Section 3 illustrates some critical issues in the implementation of the regulation reform. Sections 4 to 6 describe the dataset, the model used, and the results from our empirical analysis. Finally, Section 7 discusses the findings. A data appendix conclude the paper.
2 A very brief history of the motorway industry in Italy

Motorways services are provided in Italy by about 20 different concession holders, with the exact number depending on the definition of motorway used. The object of the franchise contract is usually the motorway maintenance and the provision of motorways services; in some cases, the franchise contract has also included the construction of new motorways or the enlargement of existing ones. Mostly for historical reasons, concessions holders are very different in nature and size, whatever working definition of size and nature is adopted. For instance, the concession holder “Autostrade per l’Italia” controls about half of the entire national network, with this figure increasing to more than 60% in one also takes into account other franchisees under its proprietary control. In terms of Km. per year, again “Autostrade per l’Italia” is clearly the largest franchisee, accounting for about 65% of the total amount of kilometers travelled on its network with respect to the nationwide figure. In terms of ownership structure, ASTM (Autostrada Torino-Milano, now SIAS) has been quoted in the Italian stock market since the early 80s, while Consorzi Siciliani is still fully controlled by local public authorities.

The construction of a toll motorways network in Italy started in the 50s, and was undertaken partly directly by ANAS, the State Department for toll and no-toll motorways, and partly under the terms of franchisee contracts. Franchisees were mostly state-owned and not selected on a competitive basis. Where concessions involved large investments (either in new motorways or for the enlargement of existing ones) funding was largely granted by the State. Even when this was not the case, the State guaranteed the loans taken up by the franchisee to finance the investment. Prices were meant to grant revenues sufficient to cover costs and were changed yearly by the Ministry of Transport; the same rate of change was in general applied to each franchisee and to the unit price charged in each
vehicle class. Franchisee’s costs were assessed by means of the so-called “piano finanziario” (PF henceforth), which was to be presented at the beginning of the concession period, and detailed the forecast for all costs and revenues for the whole period of the concession.

During the 90s, a radical reform of the industry was undertaken. The two most important changes relates to the ownership of the franchisees and the regulatory framework. As to the change in ownership, many franchisees were privatised, with the most evident example being the privatisation of Autostrade (now Autostrade per l’Italia), which took place in 1999. However, this was not the only change of ownership for motorways concessionaires in recent years, as shown in Table A4. The Table indeed shows that the number of privately owned franchisee increased from 2 in 1992 (or 8, according to the working definition of private ownership) to 12 in 2003 (16, respectively).

The other important change occurred refers to the reform of the regulatory regime. The new regulatory framework was defined in December 1996 with the CIPE Directive, which concluded a process that lasted several years. This Directive provided for the renegotiation of all the existing franchise contracts. The new contracts had to adhere to the principles laid out in the Directive, amongst which the main ones are:

- price regulation based on a price cap formula, with the X factor set every five years;
- cost observation based on the PF, provided by the franchisee at the beginning of the franchise contract and being part of the contract itself. The PF is meant to be valid for the whole period of the concession and has to be updated only in special circumstances.

The price cap formula adopted in the new contracts is applied to the prices charged by the concessionaire to each vehicle belonging to a given class for each
Km travelled on the motorway. The price cap formula limits the increases of a Laspeyres index of these prices to the rate of inflation, adjusted for expected productivity gains and changes in the quality of services provided. In particular, the price cap formula takes the following form:

\[
\left[ \frac{\sum_{i=1}^{n} p_i^t q_i^{t-1}}{\sum_{i=1}^{n} p_i^{t-1} q_i^{t-1}} - 1 \right] \times 100 \leq \Delta RPI - X + \beta \Delta Q
\]

where \( p_i^t \) and \( p_i^{t-1} \) are the (per Km) price paid by a vehicle of type \( i \) in year \( t \) and \( t - 1 \) respectively, and \( q_i^t \) and \( q_i^{t-1} \) are the total number of Kms travelled by vehicles of type \( i \) in year \( t \) and \( t - 1 \) respectively. Also, \( \Delta RPI \) is the (expected) change in the Retail Price Index and \( X \) is the offset productivity factor. The final term is the change in a composite quality index \( Q \), multiplied by a scaling factor \( \beta \).

3 Critical issues of the new regulatory framework and related literature

The first period of application of the new regulatory regime in the motorways sector has highlighted some critical issues related to the settings of the \( X \) factor and the inclusion of the quality index \( Q \) in the price cap formula. We provide some general discussion on these issues in this section.

\( X \) factor

In price cap regulation, the \( X \) factor grants that the price level follows any change in productivity. To avoid reducing the power of the incentives to cost reduction, the \( X \) factor should be set equal to expected rather than realised productivity gains. This feature of PC regulation, and the related fact that the \( X \) factor is predetermined for a given number of years, differentiate this form of regulation from ROR regulation, where, at least in principle, prices follow closely realised costs.
Theoretical literature on regulation has celebrated the PC rule as superior to ROR, emphasizing the differences in providing incentives for better production technology and overall greater efficiency of the production process. Cabral and Riordan (1989) firstly showed that PC regulation leads to greater investment in cost reduction than the ROR: the intuition of their result lies on what is known as the “Arrow effect”\(^1\) where the incentive for cost reduction (i.e.: process innovation in their context) is larger in a competitive market than in a monopolistic one, as the inventor’s incentive under competition relates to the cost reduction on the competitive output which – in turn – is larger than the monopolistic output.\(^2\) Since PC regulation specifically allows downward price flexibility, by the Arrow effect, it results as superior to ROR regulation. Moreover, the firm’s level of investment in cost reduction is nondecreasing in the length of time between revisions: this follows from the fact that larger the regulatory lag, longer the period over which the firm is able to appropriate of cost reduction.

The Cabral and Riordan (1989) stylized model produces ambiguous results with respect to consumer welfare. Clementz (1991) shows in a three period model that consumer’s surplus is larger under PC than under ROR regulation. The relevant hypothesis for this result is that the distribution \(F(c, e)\) - where \(c\) and \(e\) are respectively the firm’s cost and the effort in cost-reducing investment - is known to the regulator and, thus, that PC is always adjusted to cost.

Whilst both analyses are useful, they share the significant shortcomings of not assuming information asymmetries between the firm and the regulator and/or uncertainty about cost and demand conditions. Sibley (1989) shows that when the firm has superior information with respect to costs and demand compared to the regulator, PC regulation - under specific assumption - may come close to second-best solutions. Schmalensee (1989) and Lewis and Sappington (1989)

\(^1\)Arrow, (1962).
shows that the superiority of PC regulation become far less clear cut when there is uncertainty about cost and demand condition.

Empirical research on the comparison between PC and ROR regulation highlights the effects on costs, prices and productive efficiency; these contributions show how difficult is to sort out the effect of regulation from the effect of other factors and - in summary - it leads to mixed conclusion.

As for the effects on costs and productive efficiency, telecommunication sector seems to be the more investigated. Shin and Ying (1993) carried the first econometric test on the effect of incentive regulation on costs over the 1988-91 period for the local exchange carriers (LECs) and they find no evidence that PC regulation have significant effects on cost reduction. Over the more recent period 1988-94, similar results were obtained - combining translog cost function estimation and total factor productivity growth decomposition for a sample of LECs - by Resende (1999). Schmalensee and Rohlfs (1992) compared total factor productivity (TFP) growth for AT&T switched services before and after the introduction of PC regulation (1986-1988; 1989-1991): their results show that TFP grew faster under the PC regulation than it did in the previous three years before its introduction. Tardiff and Taylor (1993) using cross section and time series data for large LECs found that incentive regulation increases annual TFP by 2.8%. Also the impact on efficiency has been investigated. Majumdar (1997) and Resende (2000) employ data envelopment analysis (DEA) techniques to evaluate efficiency gains for distinct regulatory regimes and both conclude that incentive regulation induce higher level of productive efficiency than traditional ROR regulation. Quite opposite results have been obtained by Uri (2001) by using both DEA and stochastic frontier methodologies. This discrepancy, although striking, might be due to the different choice of inputs and outputs and by different sample analysed. Finally, the impact of PC vs ROR regulation in industries other than telecommunications have been
analysed. The overall results are mixed.\(^3\)

In the regulatory practice of the motorways industry in Italy, the actual determination of the \(X\) factor took into account a much wider range of issues rather than simply expected productivity gains, as it is common under price cap regulation. The CIPE Directive of December 1996 itself provided for the \(X\) factor to be determined mainly on the basis of expected productivity gains, but also to ensure a fair return on capital, to grant enough revenues to finance some investment programs, to take into account estimates of demand growth and change in the competitive conditions of the industry. In practice, the \(X\) factor was set to ensure an average price level able to grant the equilibrium of the whole PF, from the moment of the determination of \(X\) (for a five-year period) up to the end of the franchise contract.

This procedure is not far from one could expect, provided that the costs and revenues detailed in the PF are good enough estimates of actual trends. On the ability of the \(X\) factor to capture the gains in productivity to be expected, we will comment at length in the rest of the paper. However, it is interesting to note the value of \(X\) in the different years was set identically for 9 (out of 20) concession holders.\(^4\) These values seem to indicate what the regulator thought was the expected gain in productivity according to the industry-wide technological dynamics, or, in other words, the regulator’s expectation on the the firm’s actual performance against some predefined reference or benchmark performance.

In a recent contribution, Jamasb, Nillsen, and Pollit (2004) note that the use of benchmarking can lead the firm to pursue virtual rather than true performance

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\(^3\)For a study in the electricity generation sector in the US, see Knittel (2002).

\(^4\)More specifically, these values are 1.09 for the year 2000, 0.98 for 2001, 0.90 for 2002, 0.83 for 2003 and 0.77 for 2004. Departures from these values in the determination of the \(X\) factor could have been motivated only by firm-specific issues, such as investment programs, low initial level of prices, etc.
improvements by gaming the regulator benchmarking in a number of ways that do not reduce the issue of asymmetric information on firm’s cost and efficiency improvement efforts. They conclude with suggestions to avoid that using benchmarking adds a new dimension to strategic firm’s behaviour.

The regulator’s correct prevision of demand represents another relevant issue in price cap determination. In fact, if economies of scale or density exist, an increase in output will lead to a decrease in average costs and the X factor should be adjusted accordingly. To forecast the demand several methodological alternative exist, ranging from autoregressive models to conditional models once good explanatory variables have been found. As a rule-of-thumb, the growth of GDP can be used as a proxy for demand growth in the motorway industry.

*Q factor*

As price cap regulation provides powerful incentives for cost reduction, quality deterioration in the service seems to follows naturally. This has been both proven theoretically (Spence, 1979, and De Fraja and Iozzi, 2004) and observed in practice (Rovizzi and Thompson, 1992). In the absence of specific provision for quality, the only discipline for the firm seems to derive from the reduction in demand. In many utilities however, firm’s demand seems not to be sufficiently elastic to quality to provide an effective countervailing incentive to quality reduction.

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5Outcomes from empirical literature on firm’s incentive to quality level under different alternative regulations do not produce a clear cut that price cap would do so badly. Tardiff and Taylor (1993) findings on US telecommunications service provision highlights that there has been no detectable negative effect of PC regulation on quality for the former Bell operating companies. This result contrasts with the service quality problems detected in the mid - to late 1980s in British Telecom following the introduction of PC regulation (Armstrong, Cowan, Vickers 1994).

6The effect of PC regulation on the quality of infrastructure is a topic investigated by Greenstein, McMaster and Spiller (1995) and by Ai and Sappington (1998). Their results show higher quality of infrastructure under PC regulation as compared to ROR regulation. However, as pointed out by Kridel, Sappington and Weisman (1996), the better quality of the infrastructure
Therefore, regulators have typically adopted two different strategies to overcome this problem, either imposing quality standards alongside price constraints, or implicitly or explicitly linking the allowed price level to quality improvements. This generates a trade-off between prices and qualities, with the firm being able to “sell” higher quality to consumers, or to provide lower quality and, at the same time, compensate consumers by means of lower prices. In the presence of asymmetry of information on the firm’s cost, the use of quality standards suffers from the difficulty of setting the standards equal to the socially optimal levels. On the other hand, some very recent research (De Fraja and Iozzi, 2004) has shown that the inclusion of a quality correction term in the price cap formula may ensure that the firm makes the socially optimal price and quality choice in the long run. Subject to a further requirement on the firm’s choices not to be “too erratic”, this is ensured if the quality adjustment term is a weighted average of the marginal effect of the quality changes on consumers’ welfare and it is not in any way dependent on the firm’s cost.

In the case of motorways regulation in Italy both strategies have been in principle adopted. Indeed, the CIPE Directive of December 1996 provided for both the setting of quality standards and the direct inclusion of a quality correction in the price cap formula. While, to the best of our knowledge, the first type of regulatory policy has not been enforced so far, we have already briefly discussed the way in which the price cap formula is corrected for quality changes. Since we will be arguing that this feature of the regulatory framework has had a powerful effects on the structure of the incentives to the franchisees, we give here a more can be related to the required investments as precondition for approval of changes in regulation, and - thus - not to the direct effects from the new regulatory mechanism. However, most of the studies mentioned in this and the previous footnote are on the TLC industry, where the condition are very clearly not monopolistic and where the market discipline may soften any negative effect of price cap regulation on the quality of the services.
detailed description of the mechanism.

The composite quality index used in the price cap formula is a weighted average of two specific quality indicators; the first related to the number of accidents (per km), under the presumption that the better is the security system in force in the motorways, the smaller is the number of accidents. The second specific quality indicators relates to the roughness of the surface, which is positively linked to the comfort of the journey. Clearly, the nature of the composite index is not satisfactory, both because it omits a very large number of features of the services actually affecting its quality and the customers’ satisfaction (such as, for instance, methods of payments, waiting time at the barrier, emergency systems, disruption from roadworks, etc.), but also because takes into account quality elements (e.g. the number of accidents) which are to some extent not under the franchisee’s control. This was recognised by all parties interested in the renegotiation of the concession contracts at the moment of writing them and lead to a mutual commitment to adopt a more comprehensive composite quality index on the occasion of the price cap revision. At the moment, to the best of our knowledge, no definite steps in this direction have been made.

The other constituent element of the quality correction of the price cap formula is the $\beta$ factor. In principle, this is an adjustment factor which allows the regulator to finely tune, according to her objectives, the change in the quality indicator with the change in the permitted prices. In the case under analysis, $\beta$ takes on a predetermined value, depending on the firm’s performance against its past performance and an industry–wide standard. Although this approach has been maintained in general in all franchisee contracts, the exact way in which the factor is defined is different between Autostrade and the other concession holders. In the case of Autostrade, $\beta$ starts from 0 (when the change in the quality performance of the franchisee brings it to a quality level below the industry–wide standard) and
increases (step-wise) up to 0.5 (when the change in the quality performance of the franchisee brings it to a quality level well above the industry-wide standard). A similar structure for $\beta$ has been adopted in the case of later contracts, with however the important changes of $\beta$ i) changing continuously with the quality of service reached by the franchisee, ii) assuming negative values in case of a worsening of the quality performance, and iii) changing more rapidly with the change in the performance when the quality of the service is high, i.e. rewarding (penalising, respectively) more those concessionaries which improve (worsen) a high quality service.

The main feature which is immediately apparent from the way in which quality enters the price cap formula is that, despite the regulator shows to have in mind some “acceptable quality standard”, it is willing to reward any increase in quality above this level. Moreover, the price increase allowed to the firm is higher the higher is the quality of the service provided. Since the marginal cost of quality is increasing but its marginal benefit to the consumers is generally decreasing (at least above a certain level), this makes immediately apparent that the quality correction is meant to ensure the franchisee covers any cost due the increase in quality. As explained above, this contrasts with the indications derived from economic analysis, which would require that the increase in the price level were related to the consumers’ higher benefits due to the higher quality of the services. Moreover, it introduces in the price cap formula an automatic mechanism to ensure the cover of (at least some type of) cost very much in the spirit of rate of return regulation.

\[\text{Informal contacts with executives of Anas, which originally suggested the present structure of quality regulation, confirm this. It appears that the } \beta \text{ factor was set having in mind, on the one hand, the increase in cost that would have been needed for a given increase of the quality of the services and, on the other hand, the increase in price that this would have needed to cover this additional cost.}\]
4 The data

In the aim to start filling the lack of information on the Italian motorway industry, a unique dataset containing information on all the 20 Italian concessionaires’ has been collected via inspection of several sources. We inspected concessionaires’ official reports, some publications from AISCAT (the concessionaires’ association), and other sources (articles of the Sole 24 Ore newspaper, R&S directory yearly published by the Mediobanca investment bank, and the AIDA directory). The database contains, over the 1992-2003 period, the following variables: firms’ financial indicators (such as costs, revenues, inputs), characteristics of the sections served (such as length, stonework, mountain sections, accident rates, total number of kilometers traveled) and concessionaires’ institutional characteristics (ownership, i.e. private vs. public ownership; type of regulation, i.e. price cap vs. rate of return).

Figures from 1 to 5 and Table A2 depict the sector its evolution it in recent years. The main observations on the data set can be summarized as follows. Firstly, the Italian motorway network is composed of a huge concessionaires (“Autostrade per l’Italia”) and 19 small ones. The differences between mean and median values of the last two rows of Table A2 clearly witness this asymmetry. Secondly, a constant upward trend in total kms travelled can be observed, the order of the yearly growth rate being approximately 3%. Finally, since 1999, a sharp increase in profit before tax (notably in 2002-03) and in maintenance costs is found, while a slight decrease in labour costs has to be recorded all over the period. Whereas it would be tempting to directly comment these changes we defer the interpretation to the last section, in order to relate these figures with the

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8 For more details on data sources and variable construction, see the data appendix.
9 All figures report median values and not average values as the latter are highly affected by the figure of “Autostrade per l’Italia” much larger than the other concessionaires. Furthermore, costs and profits have been deflated with a cpi index to make them comparable over time.
econometric results.

5 The model

We estimated a total cost function with three inputs, one output and a variable representing the network length in a translog specification. We also added neutral technical progress, some hedonic (control) variables reflecting the characteristics of the network and, most importantly for the purposes of this paper, we also added some ownership and regulation dummies. The model we estimate is therefore:

\[
\ln \left( \frac{TC}{P_m} \right) = \beta_0 + \beta_o \ln \left( \frac{p_o}{P_m} \right) + \beta_l \ln \left( \frac{p_l}{P_m} \right) + \\
+ 1/2 \beta_{oo} \left[ \ln \left( \frac{p_o}{P_m} \right) \right]^2 + 1/2 \beta_{ll} \left[ \ln \left( \frac{p_l}{P_m} \right) \right]^2 + \\
+ \beta_{ol} \left( \ln \left( \frac{p_o}{P_m} \right) \ln \left( \frac{p_l}{P_m} \right) \right) + \\
+ \beta_y \ln y + \beta_{yy} \ln y^2 + \beta_{oy} \ln \left( \frac{p_o}{P_m} \right) \ln y + \beta_{iy} \ln \left( \frac{p_i}{P_m} \right) \ln y + \\
+ \beta_n \ln n + \beta_{nn} \ln n^2 + \beta_{on} \ln n \ln \left( \frac{p_o}{P_m} \right) + \beta_{ln} \ln \left( \frac{p_l}{P_m} \right) \ln n + \beta_{yn} \ln y \ln n + \\
+ \beta_t + \beta_{st.\, work} \cdot stonework + \beta_{own} \cdot own + \beta_{reg} \cdot reg + \epsilon
\]

where \( TC \) is total operating cost, \( p_m, p_o, \text{ and } p_l \) are prices for maintenance, other inputs, and labour. \( y \) is the total number of kilometers travelled (the output) and \( n \) is the network length. \( t \) is a time trend and \( stonework \) is the number of stoneworks standardised for the length of the network. \( ownership \) and \( reg \) are two time variant dummy variables. The former indicates whether the concessionaire is under private or public ownership (1 for private, 0 public) and the latter takes a value of 1 if the firm is under price cap regulation and 0 if it is under a ROR regime.

All variables are indexed \( i, t \) with \( i = 1, \ldots, 20 \) and \( t = 1992, \ldots, 2003 \). To impose homogeneity, all prices have been standardised by the maintenance price.
as shown in expression (2). In order to ease the computation of elasticities, we also standardised all prices, network, kms travelled, and total cost by their median.

As for the underlying technology, three measures are quite important and, to the best of our knowledge, never investigated so far in the Italian motorway industry.

A first measure is *scale elasticity*, given by

\[
\varepsilon_s = \frac{1}{\varepsilon_y + \varepsilon_n}
\] (3)

where \(\varepsilon_y\) and \(\varepsilon_n\) are the elasticity of total cost with respect to output (kilometers travelled) and the network length. It measures the inverse of the percentage increase in total cost due to a percentage increase in output and in the network length. A value above (below) 1 indicates increasing (decreasing) returns to scale.\(^{10}\)

A second measure is *density elasticity*, defined as

\[
\varepsilon_d = \frac{1}{\varepsilon_y}
\] (4)

It measures the inverse of the percentage increase in total cost due to a percentage increase in output holding the network length fixed. A value above (below) 1 indicates increasing (decreasing) returns to density. In other words, a value larger than 1 indicates that the network is underexploited, so that an increase in output induces a less-than-proportional increase in total costs.

Finally, another very important measure reflecting the characteristics of the underlying technology is the yearly rate of technical progress, measured by

\[
\varepsilon_t = \frac{\partial \ln TC}{\partial t}
\] (5)

a negative (positive) value showing technical progress (regress).

\(^{10}\)On the definitions of scale and density elasticities see Caves, Christensen, and Tretheway (1984).
6 Regression results

We estimated the model (2) using standard panel data technique.\textsuperscript{11} In particular, instead of adding cost shares and estimating the model with a SUR technique, we preferred to take into account unobservable heterogeneity and use fixed and random effects methods. Furthermore, as the translog results might be dominated by second order and interaction terms, we also estimated as a robustness check a simplified version of model (2) corresponding to a Cobb-Douglas cost function. As a consequence, Table 1 contains estimates of four models, two Cobb-Douglas and two translog specifications, each functional form estimated with both fixed and random effects.

Rather comfortingly, results in columns (3) and (4), i.e. those for the translog model estimated with fixed and random effects, are very similar. As regressors are standardised by their median, first order coefficients can be interpreted as elasticities evaluated at sample medians. First order price, output and network coefficients have the correct sign, and are all very significant. In particular, the kms travelled coefficient ranges from 0.15 to 0.11, leading to very high density elasticities (approximately from 6.5 to 9). This result confirms how the Italian motorway network is underexploited. The only remarkable differences in fixed and random effects results are the first and second order coefficients for the network. This is probably due to the very low within variation of this variable which affects the precision of the fixed effect estimates. In turn, the scale elasticity figure in column (4) should be taken with caution, and the more reliable random effect estimate of 1.14 should be preferred. This figure suggests that - at least in a neighborhood of the sample median - an increase in concessionaires size might be beneficial.

The 0.5\% figure for technical progress proves to be quite significant in both

\textsuperscript{11}The software used is Stata, version 8.2.
columns. This is mostly due to the introduction of automatic toll systems, and should be read in combination with the small reduction in labour expenses outlined in the previous section.

Firms under private ownership prove to be more productive than public concessionaires. The ownership dummy is negative and very significant in both specifications, showing that private firms enjoy a cost advantage of approximately 5% with respect to public ones.\footnote{In the estimated models shown in Table 1, the ownership dummy takes a value of 1 if the concessionaires is under the control of private firms or individuals. We checked the robustness of our results by using an alternative ownership dummy taking a value of 1 if the largest shareholder is a private firm or individuals. Results are very similar to those presented in the text.}

Finally, the introduction of a price cap regime does not seem to affect firms productivity as the regulation dummy is not significant at any reasonable statistical level.

All these results are confirmed by the estimation of the simplified (Cobb-Douglas) model in columns (1) and (2), the only exception being a lower density elasticities.

7 Concluding remarks

This paper aimed at providing, for the first time, empirical evidence on the effects of the regulatory reform of the Italian motorway industry. It is now time to combine theoretical literature with descriptive statistics and our econometric results in order to interpret the evolution of the industry, to evaluate regulatory mechanisms, as well as to provide some suggestions on how these mechanisms should be modified in the future.

Our analysis shows that, from the first years of the 90s to 2003, the productivity of the motorway industry has steadily increased. This was only partly due to
technological progress, mainly due to availability of new technologies for the toll payments. Another motivation of the increase in productivity was the increase in demand and, consequently, of the Kms travelled on the network. Since our analysis shows that the production technology clearly exhibits increasing returns to density, the sharp increase in motorways traffic (and revenues) observed in the last 10 years has caused a less than proportional increase in cost.

Our analysis shows that some factor have influenced the ability of the firms to exploit the profits opportunities made available by the change in the economic environment in which they operate. Rather surprisingly, price cap regulation is not one of these factors. In other words, the introduction of the new regulatory regime based on a price cap formula has not made the franchisees, ceteris paribus, more productive. On the other hand, we shown that ownership has mattered. Private franchisees are found to have been more able than those still state-owned to improve their productivity.

Two further phenomena emerge from our analysis. Firstly, maintenance costs have increased since the introduction of the new regulatory regime. This increase might explain, at least partially, the lack of a positive impact of price cap regulation on firms’ productivity. We also posit that the increase in maintenance costs is the effect of the quality correction term in the price cap formula, which create a mechanism through which the franchisee can influence the allowed average price level by choosing the quality of its services. In the paper, we argue that, in principle, there is nothing wrong with such a mechanism and that, under some conditions, can even lead to socially optimal outcomes. Also, it is not possible to determine whether the actual level of the services is (socially) inefficiently high. However, our critique is addressed to the way in which the quality correction is determined and, more specifically, to the possibility firms have to raise indefinitely the quality of their services and having a corresponding increase of the allowed
average price level.

The second phenomenon relates to the sharp and systematic increase in profits observed in the industry in recent years. Basically, this shows that the $X$ factor has been set too low, possibly because of an underestimation of the technological progress and/or the increase in demand which have both affected the industry in recent years. Moreover, if our conjecture relative to the rather artificial increase in quality-related investment is correct, the underestimation of the $X$ factor on the occasion of its first determination is even more severe. With this respect, we cannot do other than call for more accurate and sound forecasting methodology to be used by the regulator on the occasion of the periodic review.

References


## Table 1: regression results

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<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
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<td>$\beta_0$</td>
<td>1.99(0.00)</td>
<td>3.34(0.00)</td>
<td>0.05(0.18)</td>
<td>-0.10(0.23)</td>
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<td>$\beta_1$</td>
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<td>0.32(0.00)</td>
<td>0.31(0.00)</td>
<td>0.31(0.00)</td>
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<td>$\beta_2$</td>
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<td>0.45(0.00)</td>
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<td>0.38(0.00)</td>
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<td>-</td>
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<td>0.04(0.00)</td>
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<td>$\beta_4$</td>
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<td>0.09(0.00)</td>
</tr>
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<td>-</td>
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<td>-0.06(0.01)</td>
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<td>0.11(0.01)</td>
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<td>-</td>
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<td>0.11(0.00)</td>
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<tr>
<td>$\beta_8$</td>
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<td>-0.06(0.00)</td>
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<tr>
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<td>-</td>
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<td>0.13(0.00)</td>
</tr>
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<td>$\beta_{12}$</td>
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<td>-</td>
<td>0.08(0.00)</td>
<td>0.09(0.00)</td>
</tr>
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<td>$\beta_{13}$</td>
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<td>-0.20(0.00)</td>
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<tr>
<td>$\beta_{14}$</td>
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<td>-</td>
<td>-0.31(0.00)</td>
<td>-0.32(0.00)</td>
</tr>
<tr>
<td>$\beta_{15}$</td>
<td>-0.007(0.00)</td>
<td>-0.004(0.21)</td>
<td>-0.005(0.01)</td>
<td>-0.005(0.02)</td>
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<tr>
<td>$\beta_{16}$</td>
<td>0.01(0.89)</td>
<td>-0.28(0.16)</td>
<td>-0.04(0.46)</td>
<td>-0.22(0.06)</td>
</tr>
<tr>
<td>$\beta_{17}$</td>
<td>-0.07(0.00)</td>
<td>-0.07(0.00)</td>
<td>-0.05(0.00)</td>
<td>-0.04(0.00)</td>
</tr>
<tr>
<td>$\beta_{18}$</td>
<td>0.003(0.81)</td>
<td>0.002(0.89)</td>
<td>-0.005(0.49)</td>
<td>-0.002(0.82)</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>(0.00)</th>
<th>(0.60)</th>
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<td>Hausman</td>
<td>5.35</td>
<td>7.94</td>
</tr>
<tr>
<td>$\varepsilon_{\alpha}$</td>
<td>1.17</td>
<td>1.61</td>
</tr>
</tbody>
</table>

**Note:** Random effects panel estimates in columns (1) and (3); fixed effects
panel estimates in columns (2) and (4). Hausman is a test of orthogonality between effects and regressors. $\varepsilon_d$ is the measure of density elasticity, $\varepsilon_s$ is the measure of scale elasticity. P-values in round brackets. The number of observations is 232.

B Figures

![KMS TRAVELLED]

YEARLY MEDIAN, 1994-2003
PROFITS BEFORE TAX
YEARLY MEDIAN, 1994-2003

MAINTENANCE COSTS
YEARLY MEDIAN, 1994-2003
C Data appendix

This appendix aims at describing the data sources, at illustrating how some of the variables have been computed, and at presenting some descriptive statistics.

We collected our balance sheet data mainly through direct inspection of concessionaires’ official statements. In a couple of cases, we resorted to the AIDA database. We retrieved information on the number of kilometers travelled, on some characteristics of the network (such as the number of stoneworks) as well as the number of accidents from the AISCAT (concessionaires’ association) official reports. We retrieved information on ownership mainly from concessionaires official reports, integrating when needed with the R&S publication of the Mediobanca investment bank and with the information provided by concessionaires web sites. Information on the type of regulation has been collected by inspecting concessionaires’ official reports.

Despite our database contains information on all 20 Italian concessionaires, the sample used is not balanced as 8 observations are missing (see Table A1). This is due to two reasons: two concessionaires started operations in 1994 and two concessionaires refused to provide us the necessary data and was not possible to recover these data.

<table>
<thead>
<tr>
<th>Table A1: Structure of the panel</th>
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<tr>
<td>Frequency</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Total observations</td>
</tr>
</tbody>
</table>
The main variables used in the empirical analysis are described below and summarised in Table A2.

Maintenance and labour costs are taken from the corresponding heading of concessionaires official statements (or from the auditors’ notes) whereas other costs is the sum of materials, services (different from maintenance) and other operating variable costs, including depreciations. Price of maintenance and other costs have been obtained by dividing the total amount of each kind of cost by the network length. Price of labour has been obtained by dividing the labour costs by the average number of employees. The number of stonework is the number of bridges and tunnels long more than 100 meters, divided by the network length.

Table A2. Descriptive statistics

<table>
<thead>
<tr>
<th>variable</th>
<th>mean</th>
<th>st. dev.</th>
<th>min</th>
<th>25th</th>
<th>median</th>
<th>75th</th>
<th>max</th>
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<td></td>
<td></td>
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<tr>
<td>maintenance</td>
<td>48605.76</td>
<td>100620.08</td>
<td>319.00</td>
<td>10154.13</td>
<td>19800.26</td>
<td>37930.50</td>
<td>614376.00</td>
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<tr>
<td>labour</td>
<td>65541.92</td>
<td>138686.70</td>
<td>6730.58</td>
<td>19208.79</td>
<td>32707.13</td>
<td>46905.46</td>
<td>692732.00</td>
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<tr>
<td>other</td>
<td>41028.77</td>
<td>80027.04</td>
<td>4281.00</td>
<td>11725.05</td>
<td>18808.74</td>
<td>34592.45</td>
<td>620545.75</td>
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<tr>
<td>profits</td>
<td>65945.90</td>
<td>209506.87</td>
<td>-67818.00</td>
<td>2734.00</td>
<td>16358.00</td>
<td>45776.69</td>
<td>1764019.42</td>
</tr>
</tbody>
</table>

| prices    |        |          |        |        |         |        |        |
| maintenance | 209.48  | 125.07   | 15.95  | 121.13 | 190.60  | 275.68 | 978.35 |
| labour    | 85.71  | 11.00    | 60.23  | 77.97  | 85.21   | 92.39  | 157.30 |
| other costs | 248.75  | 195.63   | 48.32  | 121.60 | 187.31  | 300.41 | 1236.43 |

| kilometers |        |          |        |        |         |        |        |
| travelled  | 3302.41 | 8409.73  | 32.00  | 644.53 | 1195.59 | 1913.22 | 45858.57 |
| network   | 256.53  | 609.24   | 20.00  | 51.60  | 120.10  | 165.20 | 2854.60 |

Note: costs and prices are in millions lira, current prices. The number of kilometers travelled is in millions kilometers and network is in kilometers.

Regulation regime is indicated by a time-variant dummy variable which takes a value of 1 if at the end of fiscal year the concessionaire is under a PC regime (0
if ROR). Most of concessionaires have been regulated under ROR until 2000, as shown in the following table.

**Table A3:** Changes in the regulatory regime (from ROR to PC), by year

<table>
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<tr>
<th>Year</th>
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<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>Total</th>
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</thead>
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<tr>
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<td>15</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>20</td>
</tr>
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</table>

**Note:** absolute frequencies

Finally, we constructed two time-variant firm specific dummies for ownership. The first dummy takes a value of 1 (0 otherwise) if at the end of the fiscal year the largest shareholder is a private firm or individuals; the second one takes a value of 1 (0 otherwise) if at the end of the fiscal year the majority of share belong to a private firm or individuals. Table A4 describes the distribution over time of these two dummies and shows how a privatisation process has occurred.

**Table A4:** Public and private ownership, by year

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<td>9</td>
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<td>5</td>
<td>4</td>
<td></td>
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<tr>
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<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
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<td>15</td>
<td>14</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

| Total | 15 | 17 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

**Note:** Absolute frequencies. Private I is a dummy variable which takes a value of 1 if the largest shareholder is a private one (0 otherwise); Private II is a dummy variable which takes a value of 1 if the majority of stakes belongs to private firms (0 otherwise).