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Long-run regional equilibria in a large motor insurance market

Preliminary and incomplete: please do not quote

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Abstract

We propose a long-run approach to the evaluation of economic equilibrium and profitability of the motor insurance market, applying it to highly disaggregated yearly data on all Italian provinces, from the liberalization of the motor tariff in 1994 to 2011, thus spanning almost the whole history of Italian MTPL as a competitive market.

We document relatively long spells of profits and losses. Allowing for heterogeneity in the individual elasticities of premiums to losses of each province, we find that premiums and claims are cointegrated over the given sample of 18 years. Individual elasticities, contrary to the usual erratic behaviour documented in the literature, tightly concentrate in the "economically reasonable" interval around one. We augment the model with an index of motor reinsurance rates and the rate of return on Italian long-term government bonds, finding the expected negative sign for investment yields and the expected positive sign for reinsurance rates.

We conclude that the determination of local premiums does generally follow the relevant cost structure, and that no clear evidence of cross-subsidization between provinces is found. This economic behaviour seems consistent with the working of a competitive market where there is a long-run relationship between revenues and costs.

1 Introduction

It is common knowledge that the insurance market undergoes long spells of profits and of losses, driven by competitive behaviour, experience rating, swings in underwriting capital supply. Whichever the reason, such spells are cyclical.

[*]The paper has benefited greatly from discussions with our colleagues at the Group Insurance Research Dept. of Generali. All the computations in the paper are done inside the R open-source environment for statistical computing (R Development Core Team, 2012), generally using the *plm* add-on package for panel data econometrics. This paper has been prepared as a dynamic document with the *Sweave* utility (Leisch, 2002) according to the principles of literate statistical practice.

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They have been estimated to last about 5-7 years on average, but the variance is huge. Therefore it makes little sense to assess profitability or competitiveness of an insurance market looking at a(ny) snapshot of data for one single period.

We therefore approach the definition of a "stable economic equilibrium" in a long-run time-series perspective, considering premiums and claims in 95 provinces constituting the whole Italian motor insurance market, 1994 (end of tariff regulation) to 2011. We aim at verifying whether the available market data give evidence of a stable economic relationship between revenues and costs, region by region. We define stability as evidence of a mean reversion process which takes profits towards their long-term average.

Based on the considerations in Haley (2007, p.63), see also Haley (1993, 1995), we empirically translate this concept into looking for a cointegration relationship between sources of revenue and costs. Finding that costs and revenues are cointegrated region by region would mean that premiums are a "good" estimate of costs; that on average, region by region, tarification is correctly performed and there is no mutuality between regions in the long run; and that deviations from *local* equilibria (due to a shock to losses or to premiums) eventually lead to a reaction through *local* tariffs. By contrast, finding a unit root in profits would be scarcely consistent with the idea of a competitive market generating "zero" profits (i.e., a level of technical and financial profit consistent with appropriately remunerating underwriting capital)

To this end, we employ an operational definition of the "economic equilibrium" of an insurer starting from the balance between the typical sources of income, premiums and financial returns, and the typical costs: administrative and acquisition expenses and claims payments. In this respect, we can only observe the cost of claims: therefore we assume that non-claim costs (acquisition and administration) be (trend-) stationary. This is consistent with common sense and anecdotal evidence: the Motor market is mature and both technology and distribution evolve very slowly and steadily.

We add two further typical sources of cost and revenue: a typical interest rate (BTP10) as a proxy for the financial revenue from investing reserves; and an index of prices in Motor reinsurance, as a proxy for the cost of reinsuring excess risks.

2 The model

In a simplified world with two periods, today and tomorrow, insurance can be seen as a financial operation whereby the insurer offers cover to N individuals obtaining a sum p_i today (the premium) against payment of a conditional indemnity l_i with probability pr_i in case of loss tomorrow, incurring the functioning cost C for doing his business. Therefore, formally, an insurer's expected aggregated profit tomorrow can be defined as

$$\pi = P(1 + r) - L - C$$

where $P = \Sigma_{i=1}^{N} p_i$ are total premiums, $L = \Sigma_{i=1}^{N} l_i pr_i$ are total expected losses and r is the financial return rate, so that Pr is the total investment revenue.

This formulation highlights the two sources of profit for insurance: technical profit $(P - L)$ and investment revenue rP.

In a zero-profit competitive equilibrium, then, total premiums shall cover claims and functioning costs. Suppose that costs be proportional to losses (which are in turn considered a good measure of insurance market output): $C = cL$; then

$$P = \frac{(1+c)L}{1+r}$$

Linearizing this model yields $log(P) = log(1+c)+log(L)-log(1+r)$ the empirical counterpart of which will subsume unobservable c into the deterministic part (constant term plus trend) and account for financial and reinsurance variates through cross-sectionally invariant $\mathbf{d}_t$:

$$log(P_{it}) = \alpha_i + \gamma_i t + \mathbf{d}_t + \beta_i log(L_{it})$$

where L_{it} are now realized (ex-post) losses.

3 Data and descriptive analysis

We draw on a unique dataset of provincial-level premiums (P) and claims (C) for the Motor TPL market, reconstructed putting together various databases from IVASS, the Italian insurance regulator, and ANIA, the Italian association of insurers. Provincial boundaries are traced back to the pre-1998 subdivision into 95 administrative units, reconciling the data from the later subdivision into 103 (1998-2007) and then 107 and finally 110 units prior to the abolition of the Province as an administrative unit altogether.

The timespan of our analysis begins in 1994, the year the Italian motor tariff was liberalized, and ends in 2011 when data for said databases ceased to be gathered.

Loss ratios by province We consider Loss ratios, calculated as $LR = S/P$, as an indicator of technical profitability. A preliminary inspection of the time series of LRs by province, plotted in semitransparency in order to preserve readability as much as possible, reveals some degree of comovement, stronger in phases of hard market, amidst much idiosyncratic noise and a tendency of individual LRs to scatter away from the national average, ended by retrenchment phases which appear to be due to common, nationwide interventions and which signal the beginning of a hard market.

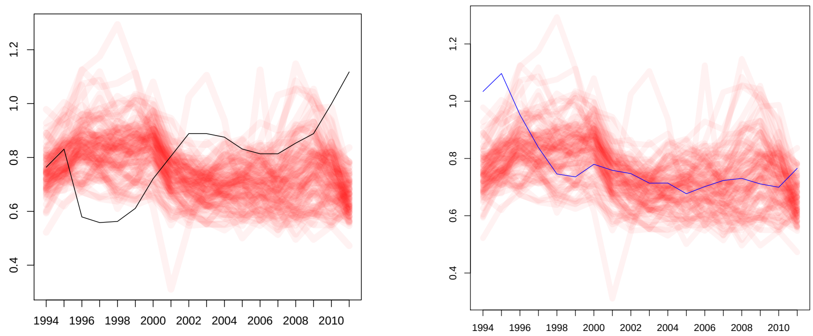
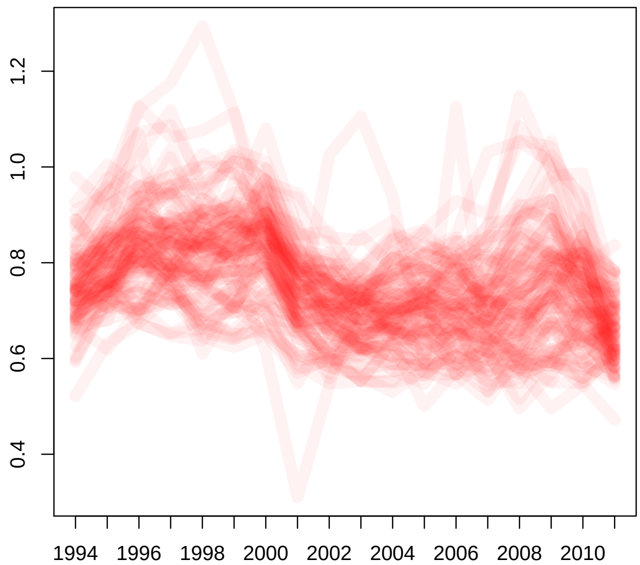


Figure 1: Provincial Loss Ratios vs. Motor reinsurance rate index (left) and 10-years fixed income yields (right)



National and supernational factors Local (ex-post) premium rates seem to correlate closely with international (ex ante) reinsurance rates. The correlation with financial yields on fixed income, long-term treasuries is less evident, while the two big retrenchment phases seem to happen after the financial crises of 2001 and 2008; although treasuries are representative of invested reserves, the role of equity is to be investigated further, perhaps in a broader view.

From a cross-sectional viewpoint, it is interesting to compare the average

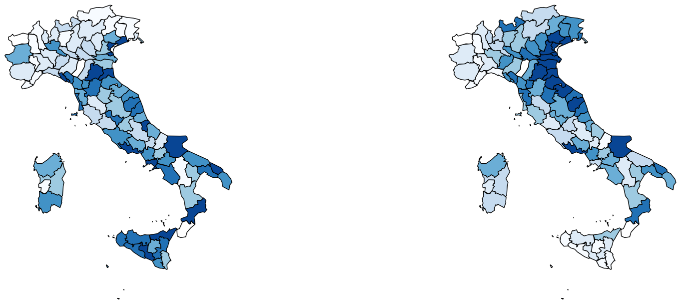


Figure 2: Maps of average loss ratio (left) and claim severity (right), 1998-2011. Darker is higher.

loss ratios on a choropleth map, in order to spot whether there are geographical clusters, or even a geographic gradient, in average LRs over the observation period: in other words, whether there is any evidence of consistent geographical mutuality between regions, with some constantly profitable ones subsidizing some other "black sheep". From a casual observation of the map in the left panel of 2, this does not seem to be the case. Compare e.g. with the distinctive pattern in claim severity emerging from the right panel, centering along some infamous roads on the Adriatic coast.

4 Stationarity analysis and modelling approach

The time series dimension of panel datasets raises the issue of possible nonstationarity and cointegration. In particular, should insurance premiums and claims be nonstationary, then two situations can occur. If there exists a stationary linear combination (i.e., they are cointegrated), then this is evidence of a long-run economic relationship between them. From an econometric viewpoint, if two (single) nonstationary time series are cointegrated, then the least squares estimator of the regression parameter characterizing the relationship is superconsistent and converges to the true value faster than its stationary counterpart (Stock, 1987). If on the contrary premiums and GDP are nonstationary but not cointegrated, the statistical relationship is spurious and least squares estimates do not converge to their true values at all, while fit and significance diagnostics yield the false positive results famously discussed by Granger and Newbold (1974).

In a panel time series context, there is one more dimension available for inference: the cross section. Under certain conditions, as shown by Phillips and Moon (1999), a spurious panel data regression can still deliver a consistent estimate of long run parameters, although its convergence properties will be weaker than those of a cointegrating one. In particular, the coefficients of a spurious panel regression will still converge to their true values, although at a much slower rate $\sqrt{N}$ than that of a cointegrating panel, which is $T\sqrt{N}$.

The high heterogeneity of our sample, comprising provinces from a very diverse country, suggests to avoid imposing pooling restrictions in the basic econometric model. We therefore consider the following linear heterogeneous panel model:

$$p_{it} = \alpha_i + d_i t + \beta_i' \mathbf{x}_{it} + u_{it} \tag{1}$$

where p_{it} indicates insurance premiums in province i at time t, $\mathbf{x}_{it}$ is a $k \times 1$ set of regressors including claims c, and possibly (long-term) government bond yields l and reinsurance rates r; α_i is a country-specific intercept, $d_i t$ is a country-specific time trend and u_{it} ia an error term. Premiums and losses are expressed in natural logs, so that the coefficient can be directly read as an elasticity.

The estimator for each individual slope coefficient can then be written compactly as

$$\beta_i = (\mathbf{x}_i' \bar{\mathbf{M}} \mathbf{x}_i)^{-1} \mathbf{x}_i' \bar{\mathbf{M}} p_i \tag{2}$$

with $\bar{\mathbf{M}} = \mathbf{I}_T - \bar{\mathbf{H}}(\bar{\mathbf{H}}'\bar{\mathbf{H}})^{-1}\bar{\mathbf{H}}'$, where I_t is an identity matrix of dimension T and $\bar{\mathbf{H}}$ contains a deterministic component comprising individual intercept and time trend (Pesaran, 2006, p.974).

Estimation of the overall coefficients can be performed either imposing parameter homogeneity (but maintaining heterogeneity in intercepts and time trends) which leads to the fixed effcts (FE) estimator

$$\hat{\beta}_{FE} = (\sum_{i=1}^{N} \mathbf{x}_i' \bar{\mathbf{M}} \mathbf{x}_i)^{-1} \sum_{i=1}^{N} \mathbf{x}_i' \bar{\mathbf{M}} p_i \tag{3}$$

and is to be preferred on efficiency grounds when the underlying assumption that $\beta_i = \beta$ is reasonable; or parameters β_i can be left free to vary, and the average elasticity $E(\beta)$ is estimated by the mean groups method,

$$\hat{\beta}_{MG} = \frac{1}{N} \sum_{i=1}^{N} \hat{\beta}_{CCE,i} \tag{4}$$

this last estimator being labeled Mean Groups (MG).

We now turn to assessing the stationarity of the series involved. The CIPS test of Pesaran (2007) will be performed first on levels:

The variables are tested for stationarity using Pesaran's CIPS test

	log(P)		log(L)	
levels	-2.4016		-1.8956	
1st diff	-2.2893	***	-2.0721	.

Table 1: CIPS test for stationarity of model variables in levels (top) and first differences (bottom). Null hypothesis is nonstationarity. Test results are reported for one lag but do not change substantially for two lags.

Both premiums and claims can be considered integrated of order one (I(1)), their first difference being stationary, although the evidence is weaker as regards claims. A further check in this respect will be provided by whether the residuals turn out to be, respectively, I(1) or stationary.

Reinsurance rates and interest rates, being nationwide factors, cannot be tested in this framework unless resorting to a simple time series test on the only 18 observations available; therefore we assume their stationarity from the beginning. The modelling phase will provide a further check in terms of their influence on cointegrating relationships.

5 Results

In the following we present the results of estimation, beginning with the simple specification (1) (1)

$$log(P_{it}) = \alpha_i + \beta_i log(L_{it}) + u_{it}$$

and then considering the augmented one (2)

$$log(P_{it}) = \alpha_i + \beta_i log(L_{it}) + \gamma_i log(re_t) + \delta_i btp10_t + v_{it}$$

	(1)		(2)	
log(L)	1.084	***	1.000	***
	(0.019)		(0.018)	
log(re)	-		0.356	***
	-		(0.019)	
btp10	-		-0.003	*
	-		(0.002)	
CD test	136.7	***	104.78	***
CIPS(2) test	-2.05	**	-2.64	**

A bivariate MG model yields a coefficient slightly above 1: and stationary residuals, which is most important because it is evidence of cointegration between premiums and claims. It must also be noted that individual coefficients, unlike what usually happens with heterogeneous estimators, scatter in a rather narrow region of plausible values near 1

Augmenting the model with motor reinsurance rates and long-term bond yields, the elasticity of premiums to losses turns out closer to one than in the bivariate model. Moreover, both added regressors have the expected sign and are significant, RE rates the more so. Short-term bond yields, by contrary, are not (alternative specification, not shown).

In order to assess the possibility of long-term subsidizing across provinces, we consider the fixed effects α_i from the MG model. Then we consider the geographic distribution of the individual elasticities to claims β_i from the MG model (2). Lastly, the distribution of the individual elasticities to claims β_i.

Fixed effects and individual elasticities look almost exactly specular on the map: provinces that have a higher intercept do react less promptly to changes in claims. Nevertheless, none of the fixed effects are significant, and the individual elasticities also scatter in a very narrow range, especially compared with the broad, usually even implausible, range of values commonly taken by individual estimates of MG models (which, one must keep in mind, are consistent only for the average coefficient β and not necessarily for each of the individual β_is, unless the time series is long enough to warrant consistent estimation of each single time series regression).

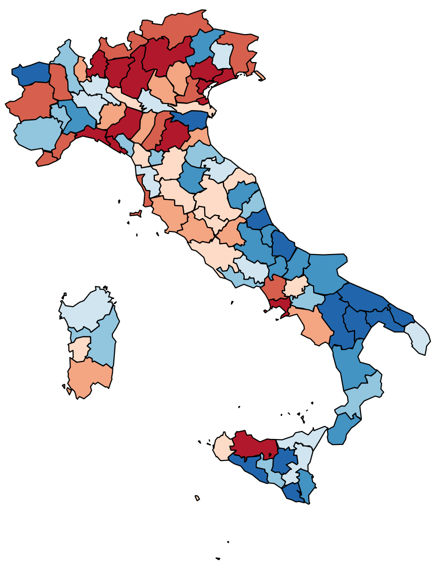


Figure 3: Individual intercepts α_i from MG model $log(P_{it}) = \alpha_i + \beta_i log(L_{it}) + u_{it}$. Reds are negative, blues positive; darker is higher in absolute value.

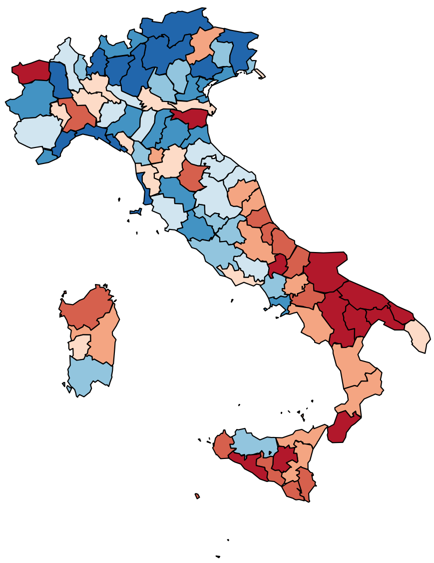


Figure 4: Individual elasticities from MG model $log(P_{it}) = \alpha_i + \beta_i log(L_{it}) + u_{it}$. Reds (dark to light) are lower, blues higher, increasing from light to dark.

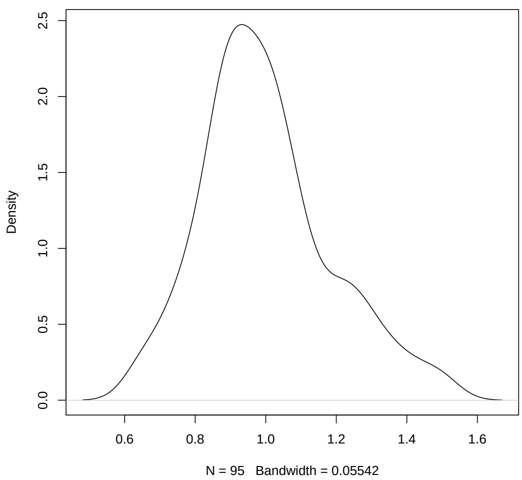


Figure 5: Distribution of individual elasticities from MG model $log(P_{it}) = \alpha_i + \beta_i log(L_{it}) + u_{it}$.

6 Conclusions

We have examined the economic functioning of the Motor insurance market in Italian provinces from 1994 (tariff deregulation) until the present day, on an individual (provincial) basis, looking at the behaviour between sources of costs and revenues, and hence at the formation of profits, in a time series perspective. Considering the well known cyclical patterns of profitability, we have tried to assess whether the market exhibits an economically sound, "healthy" behaviour *in the long run* and *across provinces*, defined according to the following features: (time series) do premiums adjust to claims on a by-region basis? and (geographic) are any regions consistently subsidizing others?

We document relatively long spells of profits and losses. Allowing for heterogeneity in the individual elasticities of premiums to losses of each province, we find that premiums and claims are cointegrated over the given sample of 18 years. Individual elasticities, contrary to the usual erratic behaviour documented in the literature, tightly concentrate in the "economically reasonable" interval around one. Augmenting the dataset with an index of motor reinsurance rates and the rate of return on Italian long-term government bonds, which are introduced into the provincial dataset as cross-sectionally invariant, national variates, we estimate a reasonably complete model of costs and revenues. In this respect, we find the expected negative sign for investment yields, which are a complementary source of revenue to underwriting margins, and the expected positive sign for reinsurance rates, which are a cost for the insurers.

We conclude that the determination of local premiums does generally follow the local cost structure quite closely; no clear evidence of cross-subsidization between provinces is found. Individual variation combines with periods of stronger comovement (nationwide retrenchment actions), following long spells of technical losses and/or associated with times of difficulty for financial profitability.

Therefore, if analyzed from such a disaggregated perspective, the Italian MTPL market shows signs of a healthy economic behaviour, consistent with the working of a competitive market where there is a long-run relationship between revenues an costs. From the viewpoint of regulators, our analysis speaks in favour of the need to consider the competitive features of insurance markets in a long-run perspective, which may mean well over a decade.

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