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Modeling the Cumulative Impact of Information Asymmetry on Algerian Insurers' Turnover: A Panel ARDL Approach (2010-2024)

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Abstract. *This study aims to evaluate and analyze the impact of information asymmetry manifested through adverse selection and moral hazard on the premium turnover and operational efficiency of the Algerian insurance market during the period from 2010 to 2024. Utilizing a panel data approach, the study examines a sample of 14 domestic insurance companies, yielding 196 dynamic observations. Methodologically, after validating slope heterogeneity and cross-sectional dependence, the Panel ARDL approach (Pooled Mean Group estimator) was deployed to capture both short- and long-run equilibrium relationships. The econometric results reveal significant structural heterogeneity among insurers in their vulnerability to informational imbalances. Notably, the error correction term (COINTEQ) was estimated at -0.18, being both negative and statistically significant. This confirms a long-run equilibrium adjustment mechanism whereby approximately 18% of short-run disequilibrium is corrected in each time period. Long-run estimations demonstrate a powerful, statistically significant negative impact of the loss ratio (LR) on corporate turnover, whereby a 1% increase in the loss ratio induces a 1.54% structural contraction in turnover. This outcome underscores the long-term accumulation of claims triggered by fraudulent tendencies and unrationalized customer behaviors. Furthermore, the reinsurance ratio (RI) exerts a significant negative long-run impact of 0.28%, highlighting that while risk-transfer mitigates uncertainty, it simultaneously dilutes domestic premium retention. Based on these insights, the study recommends empowering regulatory bodies and the "Alfa Agency" to institute specialized behavioral laboratories to detect the 50% of uninvestigated fraudulent claims, alongside adopting risk-bundling mechanisms and dynamic pricing models to stabilize the market.*

Keywords: *information asymmetry, loss ratio, reinsurance ratio, turnover, panel ARDL*

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İnformasiya asimmetriyasının Əlcəzair sığorta şirkətlərinin dövriyyəsinə kumulyativ təsirinin modelləşdirilməsi: Panel ARDL yanaşması (2010-2024)

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Xülasə. *Bu tədqiqat 2010–2024-cü illər ərzində Əlcəzair sığorta bazarında mənfi seçim (adverse selection) və mənəvi risk (moral hazard) ilə xarakterizə olunan informasiya asimmetriyasının sığorta haqlarının dövriyyəsinə və əməliyyat səmərəliliyinə təsirini qiymətləndirmək və təhlil etmək məqsədi daşıyır. Tədqiqat 14 yerli sığorta şirkətini əhatə edən panel məlumatlar bazasına əsaslanır və ümumilikdə 196 müşahidəni əhatə edir. Metodoloji baxımdan meyil əmsallarının heterogenliyi və kəsişən asılılıq yoxlanıldıqdan sonra həm qısamüddətli dinamikaları, həm də uzunmüddətli tarazlıq əlaqələrini müəyyən etmək üçün Pooled Mean Group (PMG) qiymətləndiricisi əsasında Panel ARDL modeli tətbiq edilmişdir. Ekonometrik nəticələr sığorta şirkətlərinin informasiya asimmetriyasına məruzqalma səviyyəsində əhəmiyyətli struktur fərqlərinin olduğunu göstərir. Səhv düzəlişi əmsalı (COINTEQ) – 0,18 olaraq qiymətləndirilmiş, mənfi və statistik cəhətdən əhəmiyyətli olmuşdur ki, bu da hər dövrdə qısamüddətli tarazlıqdan kənarlaşmanın təxminən 18%-nin aradan qaldırıldığını və uzunmüddətli tarazlıq əlaqəsinin mövcudluğunu təsdiq edir. Uzunmüddətli qiymətləndirmələr göstərir ki, zərər əmsalının (Loss Ratio – LR) 1% artması sığorta haqlarının dövriyyəsində təxminən 1,54% azalmaya səbəb olur. Bu nəticə saxta iddiaların və sığortalıların fürsətçi davranışlarının uzunmüddətli maliyyə nəticələrinə mənfi təsir göstərdiyini nümayiş etdirir. Eyni zamanda, təkrarsığorta əmsalı (Reinsurance Ratio – RI) da uzunmüddətli dövrdə mənfi və statistik cəhətdən əhəmiyyətli təsir göstərərək, onun 1% artmasının dövriyyəni təxminən 0,28% azaltdığını göstərir. Bu isə risklərin ötürülməsi ilə daxili sığorta haqlarının saxlanılması arasında mövcud olan tarazlığı əks etdirir. Əldə olunan nəticələr əsasında tənzimləyici qurumların və "Alfa Agentliyi"nin nəzarət imkanlarının gücləndirilməsi, araşdırılmamış saxta iddiaların aşkar edilməsi üçün ixtisaslaşmış davranış laboratoriyalarının yaradılması, eləcə də bazarın sabitliyini təmin etmək məqsədilə risklərin birləşdirilməsi və dinamik qiymətqoyma modellərinin tətbiqi tövsiyə olunur.*

Açar sözlər: *informasiya asimmetriyası, mənfi seçim, mənəvi risk, zərər əmsalı, təkrarsığorta əmsalı, sığorta haqlarının dövriyyəsi, panel ARDL*

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Introduction

The insurance sector is considered one of the driving forces for economic development, as it participates directly or indirectly in economic, social, and financial development (Arena, 2008). This participation aims to relieve individuals and evolving economic activities from risks; consequently, there has been an urgent increase in the need to insure these risks and avoid their losses, which, if they occur, could lead to severe damages. For this reason, the insurance sector has become one of the most important financial institution actors, much like the rest of the financial and monetary components of the economy, if not its fundamental pillar. It is regarded as a financial institution that produces services through a contractual relationship, whereby the service seeker (the insured) meets

with its provider (insurance companies) to cover a risk expected to occur in the future. These contractual arrangements are structured institutionally within what is known as the "insurance market" (Cummins & Doherty, 2006).

The concept of the market in economics occupies a highly important position, deriving its existence from microeconomics. The market is an institution through which goods and services are exchanged between buyers and sellers; without a market, the economy cannot function (Pindyck, 2018). When resources are allocated efficiently in the market, the marginal cost is equal to the marginal revenue (MC = MR), meaning that there is equilibrium (Hol, 2014). However, in such a case, the state of equilibrium is considered an exception, as the market is more prone to a state of disequilibrium known as "market failure" (Bator, n.d.1958). Market failure is characterized by a mismatch between supply and demand, increased costs over generated revenues, and inefficient resource allocation. This term is often associated with non-competitive markets (Pindyck, 2018).

Modern insurance economics have been significantly influenced by developments in contract theory, and the insurance market has been one of the most promising fields for the empirical application of this theory. Indeed, it can be argued that insurance data, by their very nature, provide a near-ideal material for testing the predictions of contract theory (Chiappori et al., 2006). Most of these predictions are expressed in terms of the relationship between the form of the contract and the "performance" that characterizes the outcome of the relationship, influencing the firm’s overall productive performance and market stability (Dionne et al., 2013).

Furthermore, it is difficult for insurance companies to offer a standardized contract model due to the complexity of the required information, the diverse nature of individuals and the structure of insurance markets. Given that information has become a key determinant of transactions between parties, it must possess certain qualitative characteristics to instill rationality in decision-making. Insurance companies must also thoroughly understand various aspects related to the evolution of contract theory, such as: the design of optimal insurance contracts, the state of equilibrium under perfect information, the state of equilibrium under imperfect information, linear and non-linear contracts, the nature and form of competition, and the role of the state in public regulation. Understanding these aspects is considered fundamental to the success of insurance companies in light of complex information and risks that cannot be measured or predicted.

In addition to the aforementioned, market forces typically drive insurance companies to engage in risk classification to mitigate information problems and establish a sound foundation for decision-making. This is achieved by identifying risk pools, offering optimal insurance contracts tailored to various risk levels, and avoiding consequences that negatively or incorrectly categorize individuals regarding their degree of risk (Crocker & Snow, 2011). Here, we discuss two types of classifications and their implications: exogenous (external) risk classification and endogenous (internal) risk classification. A common feature of these classifications is that they need to be linked to heterogeneity, perceived as fair by consumers, and possess the attribute of reliability.

Determining these classifications is one of the critical decisions within insurance companies, as the firm's success in investment, business operations, and maintaining financial solvency depends heavily upon them. In addition to the paramount importance of these classifications, certain aspects must be taken into account when pricing insurance policies. These include the nature of price competition among insurers, the expected volume of demand for insurance policies, the extent of compliance with rules and conditions issued by regulatory bodies, and the trend advocating for the deregulation of the insurance industry (Biener et al., 2016). Furthermore, insurance companies must not overlook the presence of information asymmetry when setting prices, as well as the impact of this equilibrium price on ensuring the soundness of their financial position (Albercher, 2017).

The American economist George Akerlof (1978) was the first to introduce the phenomenon of asymmetric information in his seminal paper titled "The Market for Lemons", for which he was awarded the Nobel Prize in Economic Sciences in 2001. The American economist chose this title because his research examined an economic example of the used-car market, where Americans colloquially refer to defective or poor-quality cars as "lemons". He applied his research to several fields, including financial markets and insurance economics, concluding that contractual relationships are predominantly characterized by an imbalance of information between the parties involved, which leads to inaccurate outcomes due to flawed decision-making (George, 1978).

The problem of information asymmetry is considered a variable that negatively impacts the determination of the baseline price for an insurance policy, which must be carefully accounted for (Acqua, 2026). In this context, we distinguish two types of risk associated with this problem: adverse selection and moral hazard (Yan & Lee, 2023). It is essential here to differentiate between these two concepts, which differ in their temporal nature; existing literature indicates that adverse selection occurs *prior* to the signing of the contract, whereas moral hazard occurs *after* the contract has been signed (Pauly, 2024). It is worth noting that a distinguishing feature of this situation is that policyholders can alter their behavior. Consequently, insurance companies must implement the necessary measures to balance these two phenomena, which can adversely affect their operations, overall performance, and productive efficiency (Sheth, 2021).

In this regard, it is notable that studies assessing and estimating the losses incurred by insurance companies due to asymmetric information risks within the European Union have estimated the cost to be 10% of the total amount of claims. This percentage is subject to increase in countries suffering from a lack of insurance regulatory and supervisory systems, as is the case in developing nations (Najar et al., 2025). Turning to the Algerian insurance market, according to the "Alfa" agency, only 50% of financial losses resulting from insurance fraud cases are investigated. The remainder goes undetected due to the shortage of specialized laboratories dedicated to studying behavioral aspects by analyzing policyholders' decisions regarding insurance fraud (Banulescu-Radu & Yankol-Schalck, 2024). This, in turn, leads to the emergence of irrational variables manifested as risks of asymmetric information. Therefore, it is of significant interest to examine the impact of this problem on the Algerian insurance market and the efficiency of insurance companies, as well as to analyze its various effects. Based on the foregoing, the following research problem can be posed:

To what extent does the problem of information asymmetry impact the Algerian insurance market?

To address this research problem and examine its various dimensions, this study seeks to achieve a set of core objectives, which are outlined as follows:

- Deconstructing the Mechanisms of Information Asymmetry: By determining how the phenomena of adverse selection and moral hazard affect the structure of the Algerian insurance market and their relationship with policyholders' behavior.
- Diagnosing the Reality of Fraud and Behavioral Impact: By monitoring and analyzing the irrational variables and regulatory gaps that contribute to increasing the proportion of undetected financial losses in the national market.
- Providing Practical Solutions and Mechanisms: By proposing preventive measures and quantitative or behavioral models that assist Algerian insurance companies in balancing these risks and improving their productive efficiency and overall performance.
- Furthermore, this study derives its paramount importance from its practical and analytical nature, where the research's value added lies in:
- Bridging the National Knowledge Gap: Addressing the scarcity of local studies (and specialized laboratories) that integrate the behavioral dimension into the analysis of fraud decisions within the Algerian insurance environment, compared to the available European studies.

- Supporting Decision-Makers and Insurance Companies: Providing an accurate diagnosis and benchmark indicators for the "Alfa Agency" and regulatory bodies to reduce the volume of financial losses resulting from insurance fraud (which exceeds the 50% threshold for undetected losses according to available indicators).
- Enhancing Economic Efficiency: Contributing to laying the strategic foundations for fair and sound pricing of insurance policies, thereby enhancing trust and transparency between the parties of the contractual relationship and serving the national economy as a whole.

Previous Studies

Recent economic and financial literature has extensively examined the phenomenon of information asymmetry and its distinct dimensions namely, adverse selection and moral hazard identifying it as one of the most critical challenges threatening the efficiency and sustainability of insurance and reinsurance markets. The reviewed literature can be categorized into several key thematic pillars that reflect both the methodological and geographical evolution in studying this phenomenon:

Geographical Scope: Contrasting Developed and Developing Markets

The literature demonstrates a consensus that the operational manifestation of information asymmetry varies fundamentally based on the developmental stage of the market's institutional and regulatory framework. In developed markets characterized by complex organizational structures and massive datasets, Wen (2010) provided definitive empirical evidence of the simultaneous existence of both adverse selection and moral hazard within United States insurance and reinsurance companies (Wen, 2010).

Conversely, Hussain and Ahmed (2019) introduced new analytical horizons regarding the unique specificities of developing nations through their application to the Pakistani market (Hussain & Ahmed, 2019). They argued that testing for the existence of adverse selection using conventional, classical methodologies (commonly deployed in advanced economies) often yields mixed results or "limited" evidence. This limitation is primarily attributed to the structural deficiencies in ex-ante risk screening mechanisms. Nevertheless, their study demonstrated that the problem in developing countries assumes a different dimension, directly intersecting with contractual vulnerabilities in sensitive lines such as health insurance. This friction triggers severe financial imbalances that necessitate innovative, protective strategies tailored to these developing environments.

Information Asymmetry within the Reinsurance Market

The reinsurance sector occupies a central position in these academic debates. Wen (2010) in the US (Wen, 2010) and Maharjan (2021) in Nepal reached a consensus that the process of risk transfer from primary insurers to reinsurance companies yields a highly fertile environment for information asymmetry.

The Nepalese study utilized an econometric approach that established a strong positive correlation between the incurred loss ratio and the reinsurance ratio across various portfolios (fire, marine, and motor insurance). This implies that primary insurers either tend to cede risks that are highly susceptible to losses (the essence of adverse selection) or become less prudent once the risk has been offloaded to the reinsurer (the essence of moral hazard) (Maharjan, 2021).

Productive Efficiency and the Structural Network of Market Stakeholders

Rather than merely mapping the relationship between risk transfer and loss ratios, the literature expanded to quantify both the macro and microeconomic impacts of the phenomenon. Feki (2016) offers a sophisticated model in the Tunisian context by employing advanced parametric and non-parametric quantitative techniques (Chiraz, 2016), specifically the Cobb-Douglas production function and Data Envelopment Analysis (DEA) across extended timeframes. By constructing a

baseline model assuming the absence of the problem against an augmented model accounting for its presence, the researcher concluded that the proxy variables for information asymmetry (the loss ratio and reinsurance ratio) trigger a direct structural decline in the operational efficiency of firms.

From another perspective, Rybák (2015) dissected the structural anatomy of the commercial insurance market in the Czech Republic by identifying the motives and sources of information asymmetry across the three primary stakeholders of the insurance value chain: the client, the intermediary, and the insurance company (Rybák, 2015). The study delineated the detrimental reciprocal impacts resulting from each participant's pursuit of concealing data to maximize personal utility.

Proposed Supervisory Mechanisms and Strategic Solutions
Studies with a prescriptive or remedial focus unanimously converged on the necessity of formulating strategic frameworks that transcend static analysis to offer structural remedies. While the Czech study (Rybák, 2015) concentrated on delivering organizational solutions designed to elevate transparency levels between intermediaries and clients (Rybák, 2015), the research on developing nations (Hussain & Ahmed, 2019) put forward a highly significant practical proposal. This framework relies on re-engineering insurance contracts through a "risk bundling" mechanism and mandating group or family coverage within the health insurance sector. This serves as a primary defensive mechanism to counteract adverse selection vulnerabilities and protect insurance markets from potential financial collapse driven by the opportunistic behavioral choices of consumers.

Methods

This study relies on data obtained from a variety of sources, namely the annual reports of the following insurance companies: (TALA, SAPS, CARDIF, CNMA, TRUST, CAIR, ALLIANCE, 2A, SALAMA, GAM, CASH, CAAT, CAAR, SAA).

This covers the period spanning from 2010 to 2024, meaning that N = 15, subject to data availability (where T = 14). Consequently, the total sample size is N × T = 15 ×14 = 210. The data will be processed using panel data; the first refers to the Pooled Ordinary Least Squares (POLS) model, the second denotes the Fixed Effects Model (FEM), whereas the third model represents the Random Effects Model (REM). We will differentiate between these models based on certain statistical tests. Initially, we test for the potential presence of an individual effect within the studied sample.

This is conducted via an F-test, where the null hypothesis assumes the appropriateness of the Pooled Regression Model (the absence of an individual effect in the studied sample). Accordingly, we obtain the alternative model for the dependent variable, which is the turnover of insurance company *CA*.

$$CA_{i,t} = a + \beta_1 LR_{i,t} + \beta_2 RI_{i,t} + \mu_i + Y_t + \varepsilon_{i,t}$$

$CA_{i,t}$: The turnover of insurance companies for firm (i) in time period (t).
$LR_{i,t}$: The loss ratio for firm (i) in time period (t).
$RI_{i,t}$: The reinsurance ratio for firm (i) in time period (t).
μ_i : Unobserved cross-section effects, which vary across companies but remain constant over the same time period.
Y_t : Unobserved time effects, which are shared among the studied companies but vary over time
εit : The random error term, which is assumed to be independently and identically distributed.

Results and Discussion

Determining the Appropriate Model for the Study Data
We will estimate the aforementioned equation using the Ordinary Least Squares (OLS) method. Based on the longitudinal (panel) data of the study, we distinguish between three types of panel data models: the Pooled Regression Model (POOLED), the Fixed Effects Model (FEM), and the Random Effects Model (REM). The first and second models are estimated using Ordinary Least Squares (OLS), whereas the third model is estimated using Generalized Least Squares (GLS). Subsequently, we will differentiate and select the most appropriate model among them (Baltagi, 2021).

Table 1
Estimation of the appropriate model for the study data

Dependent Variable (CA)			
Time period: 2010-2024 T=15 N=14			
Independent Variable	Pooled Model	Fixed Effects Model	Random Effecte Model
LR	-1.28	-0.35	-0.38
	(0.00)	(0.00)	(0.00)
RI	-0.78	-0.48	-0.33
	(0.00)	(0.00)	(0.00)
Constant	2.88	3.64	3.58
	(0.00)	0.00	(0.00)
R- squared	0.31	0.89	0.08
S.E.of regression	0.37	0.15	0.15
F-statistic	47.73	106.47	9.75
Prob (F-statistic)	0.00	0.00	0.00

Source. Own elaboration based on Eviews 13output.

Initially, we determine the presence or absence of individual effects within the study sample data using a Fisher-type test (F-test). The null hypothesis of this test aligns with the total homogeneity model, indicating the absence of any individual effects in the studied sample. The test hypotheses are formulated as follows:

H_0: The Pooled Regression Model is the appropriate model.
H_1: The Fixed or Random Effects Model is the appropriate model.

$$\boldsymbol{F_1} = \frac{(R2_{MMC} - R2MC)/(N-1)}{1 - R2MMC/(NT - N - K)}$$

Where:
N: Represents the number of individuals (in our case, 14 companies).
T: Represents the length of the time series proposed in the study (in our case, 15 years).
K: Represents the number of exogenous variables in the model (in our case, there are two variables).

R^2_{MC}: Represents the multiple coefficient of determination under the null hypothesis (restricted model), which in this case is the model with no individual effects, i.e., the total homogeneity model (R^2_{MC} = 0.31).

R^2_{RMM}: Represents the multiple coefficient of determination for the unrestricted model under the alternative hypothesis, which in this case is the fixed effects model (R^2_{RMM} = 0.89).

Upon applying the Fisher test formula, the calculated F-statistic is F_c = 78.69. Meanwhile, the tabulated (critical) F-statistic is F(0.05, 13, 194) = 1.77. Consequently, we reject the null hypothesis at the 5% and 10% significance levels, concluding that there is a fixed effect within the sample data.

Testing for Effect Type: The Hausman Test
Following the Fisher test (F-test), which confirmed the presence of individual effects, we proceed to determine the nature of these effects using the Hausman specification test (Hausman, 1978). This test guides the choice between the Fixed Effects Model and the Random Effects Model. The hypotheses for this test are formulated as follows:

H_0: The Random Effects Model is the appropriate model.
H_1: The Fixed Effects Model is the appropriate model.

Table 2
Hausman test

Correlated Random Effects - Hausman Test
Pool: COM
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	13.239685	2	0.0013

Source. Prepared by the researcher based on EViews 13 outputs.

Based on the EViews 11 econometric software outputs and the results of the Hausman test, we observe that the calculated Chi-square statistic (χ^2_c= 13.23) is greater than the tabulated (critical) Chi-square statistic ($\chi^2_{0,05,2}$ = 5.99). Consequently, we reject the null hypothesis, confirming that the Fixed Effects Model is the appropriate specification for the study's sample data. Accordingly, each cross-section (country) possesses its own unique individual effect.

The table below displays the estimation results of the fixed effects for each country:

Table 3
Fixed effects estimation results by country

Company	Effect
Saa	*0.631*
Caar	*0.542*
Caat	*0.745*

Cash	*0.615*
GAM	*-0.259*
Salama	*-0.103*
2a	*-0.073*
Alliance	*-0.061*
Cair	*0.150*
Trust	*-0.078*
Cnma	*-0.519*
Cardif	*-0.380*

Source. Prepared by the researcher based on EViews 11 outputs.

The estimation results of the Fixed Effects Model (FEM) reveal significant heterogeneity among the studied Algerian insurance companies, reflecting varying degrees of susceptibility to information asymmetry. The findings indicate that several companies recorded positive fixed effects. Specifically, CAAT exhibited the highest positive intercept at 0.745, followed by SAA and CASH with values of 0.631 and 0.615, respectively, alongside CAAR at 0.542. These positive parameters imply that these companies possess superior efficiency in information management and underwriting risk assessment. Furthermore, it reflects their capacity to mitigate the adverse impacts of information asymmetry by enhancing internal control mechanisms, developing robust disclosure and communication systems with clients, and adopting more effective risk assessment and contract pricing policies.

Conversely, other companies exhibited negative fixed effects, most notably CNMA at -0.519, followed by CARDIF at -0.380, and GAM at -0.259. These negative coefficients suggest that these firms are more vulnerable to adverse selection and moral hazard issues arising from information asymmetry, which negatively impacts their financial performance and operational efficiency. These negative effects may also be attributed to deficient information systems, weak financial disclosure, or a lack of robust risk assessment and monitoring tools within these corporations.

Moreover, the F-test results, which confirmed the statistical significance of the individual effects, demonstrate that Algerian insurance companies do not share identical characteristics or equal capabilities in addressing information asymmetry. This justifies the adoption of the Fixed Effects Model as the most appropriate specification for capturing individual variations across companies over the study period from 2010 to 2024. Consequently, it can be concluded that information asymmetry affects Algerian insurance companies to varying degrees; while some firms successfully adapt and mitigate its repercussions, others suffer from its adverse impacts on financial performance and stability. These findings underscore the critical importance of fostering transparency, enhancing financial disclosure, and upgrading information systems and corporate governance within the Algerian insurance sector to minimize the information gap and improve overall market efficiency.

Evaluation of the Fixed Effects Model (FEM)
Having established the Fixed Effects Model (FEM) as the most appropriate specification through prior statistical testing, the model's estimated equation can be formulated as follows:

$$CA = a - 0{,}35LR_{i,t} - 0{,}48RI_{i,t} + \mathcal{E}_{i,t}$$

Economic Evaluation (Interpretation of Parameters)
The Loss Ratio (LR) Coefficient: The loss ratio exerts a statistically significant negative impact on the turnover (CA) of Algerian insurance companies. LR 1% increase in the loss ratio (CA) leads to a 0.35% decrease in turnover. Economically, this inverse relationship indicates that an increasing loss ratio reflects a higher volume of claims relative to written premiums. This diminishes corporate profitability, erodes competitive advantage, and ultimately leads to a contraction in underwriting volume and overall insurance activity. The Reinsurance Ratio (RI) Coefficient: The reinsurance ratio likewise exhibits a statistically significant negative impact on the turnover of Algerian insurance companies. RI 1% increase in the reinsurance ratio (CA) results in a 0.48% decline in turnover. This negative effect is explained by the fact that a higher level of reinsurance implies ceding a larger share of premiums to reinsurers, thereby reducing premium retention within the domestic company. Consequently, this adversely affects direct turnover, driven by risk aversion towards information asymmetry and market uncertainty.

Statistical Evaluation
The model estimation results reveal a coefficient of determination (R^2) of 0.892 and an Adjusted R^2 of 0.883. This indicates that the exogenous variables included in the model explain approximately 88% to 89% of the variance in the dependent variable, demonstrating a high explanatory power and a robust goodness-of-fit. The remaining variance is attributable to omission factors not captured by the model or to stochastic error. The F-statistic of 106.47, coupled with a highly significant p-value (Prob (Fstatistic) = 0.00), confirms the overall statistical significance of the estimated model. Consequently, the independent variables jointly exert a significant impact on the dependent variable. Regarding estimation quality, the Standard Error of the Regression (S.E. of regression) is approximately 0.153, indicating a relatively low magnitude of residual variance and acceptable estimation precision. Furthermore, information criteria–namely the Akaike Information Criterion (AIC), Schwarz Criterion (SIC/BIC), and Hannan-Quinn Criterion (HQ)–support the model's quality for potential cross-model selection.

Conversely, the Durbin-Watson (DW) statistic of 0.814 indicates the presence of a positive first-order serial correlation (autocorrelation) in the residuals, which warrants further diagnostic testing or corrective procedures to ensure valid statistical inference.

Overall, while the model is acceptable in terms of statistical significance and possesses strong explanatory power, the presence of positive autocorrelation in the residuals implies specification weakness from an econometric standpoint. Accordingly, the estimated static panel model is somewhat inadequate, thereby justifying the transition to dynamic panel data estimation to capture short- and long-run relationships.

Short- and Long-Run Relationship Estimation: Dynamic Panel Data
Cross-Sectional Dependence Testing:
Cross-Sectional Dependence (CSD) testing is a crucial methodological step in panel data analysis to detect potential contemporaneous correlation across cross-sectional units. The empirical results of the most prominent cross-sectional dependence tests indicate that the calculated statistics reject the null hypothesis of cross-sectional independence. This confirms the presence of a statistically significant cross-sectional dependence across the sampled units, driven by the highly significant test coefficients. This interdependence reflects the systemic linkages among the utilized series (Pesaran, 2015). The table below details these findings:

Table 4
Cross-sectional dependence test results

Variable	Breush-Pagan LM	Pesaran Scaled LM	Pesaran CD
		Dependent variable	
CA	*596.00* *0.00*	*37.43* *0.00*	*21.00* *0.00*
		Independent Variable	
LR	*159.54* *0.00*	*5.08* *0.00*	*1.33* *0.00*
RI	*173.63* *0.00*	*6.12* *0.00*	*-0.75* *0.00*

Source. Prepared by the researcher based on EViews 13 outputs.

The results of the Breusch-Pagan LM, Pesaran Scaled LM, and Pesaran CD tests indicate the presence of statistically significant cross-sectional dependence among the cross-sections (insurance companies) regarding the dependent variable (Claims/CA) as well as the independent variables (Loss Ratio/LR and Reinsurance Ratio/RI). All probability values (Prob = 0.00) were found to be below the 5% significance level. Regarding the dependent variable (CA), the Breusch-Pagan LM test statistic reached approximately 596.00, while the Pesaran Scaled LM statistic was approximately 37.43, and the Pesaran CD statistic was around 21.00. All these values are statistically significant, confirming a strong correlation among the insurance companies under study, implying that shocks or changes occurring in one company can be transmitted to others.

As for the independent variables, the results also demonstrated significant cross-sectional dependence. The Loss Ratio (LR) recorded values of 159.54 for the LM test and 1.33 for the Scaled LM test, both with strong statistical significance. Similarly, the Reinsurance Ratio (RI) recorded values of 173.63 and 6.12** respectively, all of which are statistically significant.

Consequently, it can be concluded that the study data do not satisfy the assumption of cross-sectional independence; rather, they are characterized by strong cross-sectional dependence among Algerian insurance companies throughout the study period. This reflects a linkage in performance and susceptibility to economic or sectoral shocks. This significant finding suggests the necessity of employing econometric models that account for this dependence when performing estimations to ensure the accuracy of the results.

Hsiao (1986) Homogeneity Test

The Hsiao (1986) Homogeneity Test is used in panel data to verify whether the model coefficients are homogeneous across cross-sectional units (i.e., whether all countries/institutions follow the same economic relationship) or whether they differ from one unit to another.

The test is based on the null hypothesis (H0), which assumes the homogeneity of coefficients across all cross-sections, against the alternative hypothesis, which assumes heterogeneity (variation) in the coefficients among the units. If the resulting p-value is statistically significant ($p < 0.05$), the null hypothesis is rejected. This implies that the model is heterogeneous and that the relationship between variables differs from one entity to another; consequently, using a simple Pooled OLS model is inappropriate, and it is preferable to employ models that allow for variation, such as Fixed Effects or Random Effects models, or dynamic panel data models. Conversely, if the result is not statistically significant, this indicates the presence of coefficient homogeneity, and thus, a unified model can be used to explain the relationship for all units.

In general, the Hsiao (1986) test is a fundamental step prior to estimating panel data models, as it determines whether the data should be treated as a single homogeneous unit or as units with differing economic behaviors.

Table 1
Hsiao test

Hypotheses	F-Stat	P-Value
H1	44.353	6.97E-70
H2	5.090	2.59E-11
H3	79.368	3.02E-70

Source. Own elaboration based on Eviews 13 output.

The Hsiao (1986) specification test results serve to examine the degree of homogeneity or heterogeneity in panel data by comparing three primary hypotheses regarding the nature of the relationship between cross-sectional units (companies) over time. The results indicate that all statistics for the three tests (H1, H2, H3) were statistically significant at very high levels of confidence, with p-values in all cases approaching zero (well below 0.05), leading to the rejection of their corresponding null hypotheses. For the first test (H1), the F-statistic reached approximately 44.35 with a p-value of 6.97E-70, indicating the rejection of the panel data homogeneity hypothesis and, consequently, the existence of differences between the cross-sectional units.

The second test (H2) recorded an F-statistic of 5.09 with a p-value of 2.59E-11, which supports the existence of a clear variance in the model structure and a lack of total homogeneity among the companies. Regarding the third test (H3), the F-statistic was approximately 79.36 with a p-value of 3.02E-70, which further reinforces the rejection of perfect homogeneity and supports the conclusion of only partial homogeneity or cross-sectional heterogeneity among the companies under study. In light of these collective results, it can be concluded that the study data are characterized by clear heterogeneity among Algerian insurance companies throughout the study period, with observable differences in behavior and economic relationships between the cross-sectional units. Methodologically, this supports the use of heterogeneous panel models (such as Fixed Effects or Random Effects models) rather than pooled regression models, which assume complete homogeneity.

Stationarity test

Table 2
Panel unit root test

Variables	Level	1st Difference
	CIPS Test	CIPS Test
Ca	-2.024***	
Lr	-2.367***	
Ri	-2.749***	

Note. The symbols (***), (**), and (*) indicate hypothesis H_0: all panels contain unit roots is not accepted at statistical thresholds of 0.01, 0.05 and 0.1 in succession.

Given the confirmation of cross-sectional dependence and slope heterogeneity across the panel, traditional first-generation unit root tests would yield biased results. Therefore, the study employs the Cross-sectionally Augmented (CIPS) test (Pesaran, 2007), which is robust under such conditions. The empirical results presented in Table 3 indicate that all the analyzed variables namely, ca, lr, and ri are highly stationary at their level values. The null hypothesis (H0) of a panel unit root is rejected at the 1% significance level (***) for all three variables. Consequently, all variables exhibit a uniform order of integration, being stationary at level I(0), which eliminates the need to evaluate their first differences. This stationarity at level provides a robust and consistent foundation for subsequent panel data estimation and advanced econometric modeling.

Cointegration Tests

Table 3
Results of pedroni residual cointegration test

	Tests	Statistics	Probabilities
Pedroni Test	Panel v-Statistic	-2.86	0.99
	Panel rho-Statistic	-4.29	0.00
	Panel PP-Statistic	-6.82	0.00
	Panel ADF-Statistic	-3.36	0.00
	Group rho- Statistic	-1.70	0.04
	Group PP- Statistic	-8.11	0.00
	Group ADF- Statistic	-4.91	0.00

Source. Own elaboration based on Eviews 13 output.

To investigate the existence of a long-term equilibrium relationship between the study variables, the (Pedroni, 2004) 2004 Cointegration and (Kao et al., 1999) 1999 Tests were applied. This test relies on seven different statistics categorized into two groups: within-dimension (Panel) and between-dimension (Group). The results presented in the table indicate the following:

The results of the Pedroni cointegration test indicate the presence of a long-run equilibrium relationship among the model's variables for Algerian insurance companies during the study period, based on both within-dimension and between-dimension tests. For the within-dimension component, the findings demonstrated statistical significance across most statistics. Specifically, the Panel RHO-statistic (-4.29), Panel PP-statistic (-6.82), and Panel ADF-statistic (-3.36) yielded significant values at the 5% level (P-value = 0.00), leading to the rejection of the null hypothesis of no cointegration. Conversely, the Panel V-statistic lacked statistical significance (P-value = 0.99). However, this does not invalidate the overall conclusion, as the other statistics are generally considered more powerful in detecting cointegration.

Regarding the between-dimension analysis, the results similarly corroborated the existence of cointegration. The Group RHO-statistic (-1.70) was statistically significant at the 5% level (P-value = 0.04), while both the Group PP-statistic (-8.11) and Group ADF-statistic (-4.91) exhibited highly robust significance (P-value = 0.00). Based on these findings, it can be concluded that cointegration exists among the model's variables, evidencing a long-run equilibrium relationship among turnover (CA), loss ratio (LR), and reinsurance ratio (RI) within the sampled insurance companies. Methodologically, this substantiates the appropriateness of employing estimation models that accommodate long-run dynamics, such as Panel ARDL or dynamic error correction models.

Model estimation

Dependent Variable: D(CA)
Method: ARDL
Date: 05/17/26 Time: 10:50
Sample: 2011 2024
Included observations: 196
Number of cross-sections: 14
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): LR RI
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 4
Selected model: PMG(1,1,1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			
LR	-1.542643	0.085318	-18.08105	0.0000
RI	-0.287624	0.064263	-4.475738	0.0000
C	4.354468	0.050025	87.04644	0.0000
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.186509	0.094024	-1.983630	0.0487
D(LR)	-0.074422	0.104474	-0.712352	0.4771
D(RI)	-0.081807	0.297647	-0.274847	0.7837
Log-Likelihood:	359.9726			

The Error Correction Term

The estimated coefficient of the error correction term (COINTEQ01) is (-0.18). It is statistically significant at the 5% level and bears a negative sign, indicating that the error correction mechanism rectifies the model's disequilibrium. Specifically, the model incorporates an adjustment mechanism of 18% annually, which is considered a favorable rate. In other words, this suggests that the adjustment process toward equilibrium occurs gradually and at a moderate pace, as the model requires several time periods to fully absorb shocks and return to a stable steady-state equilibrium.

Long-Run Analysis

The Loss Ratio (LR): This parameter has a significant negative effect on the turnover of Algerian insurance companies. A 1% increase in the loss ratio leads to a 1.54% decrease in turnover in the long run.

This long-term negative impact reflects the deep-rooted issue of information asymmetry within the insurance market. The limited capacity of insurance companies to obtain accurate and comprehensive information regarding policyholders' risk levels exacerbates the problems of adverse selection and moral hazard. Over time, the consequences of inaccurate risk assessment accumulate, elevating the volume of claims relative to written premiums, thereby driving a continuous rise in the loss ratio. The persistence of this situation in the long run adversely affects the stability and profitability of these companies.

Consequently, insurers are compelled either to raise prices–which may suppress demand for their products–or to reduce insurance coverage. This ultimately results in a structural, rather than temporary, decline in turnover. Thus, the negative effect of the loss ratio goes beyond mere short-term fluctuations; it embodies a structural imbalance inherently tied to information asymmetry in the Algerian insurance sector.

The Reinsurance Ratio (RI): This parameter also exhibits a significant negative effect on turnover. A 1% increase in the reinsurance ratio leads to a 0.28% decrease in turnover in the long run. This indicates that insurance companies resort to reinsurance as a mechanism to transfer and distance risks, given the prevailing information asymmetry and the difficulty in accurately evaluating policyholders' potential risks. Instead of bearing the entire risk, the primary company distributes or transfers a portion of it to reinsurers to reduce the uncertainty associated with its insurance portfolio.

However, while this hedging behavior mitigates direct risk exposure, it simultaneously leads to a decrease in the volume of premiums retained internally, which negatively impacts turnover in the long run. Thus, the growing reliance on reinsurance reflects not only a risk management strategy but also a direct response to the problem of information asymmetry, prompting companies to limit their exposure to unknown or inaccurately estimable risks.

Short-Run Results

The Loss Ratio (LR): In the short run, this parameter has an insignificant negative effect on turnover. A 1% increase in the loss ratio leads to a minor 0.07% decrease in turnover. The lack of statistical significance implies that the short-term impact of the loss ratio on insurance activity is neither decisive nor stable. This may be attributed to the companies' ability to absorb short-term shocks through pricing mechanisms or the rapid rebalancing of their portfolios. Furthermore, this weak short-run effect may reflect a lag in the manifestation of information asymmetry consequences, as the problems of adverse selection and moral hazard do not fully materialize until data accumulates over time, making their impact much more pronounced in the long run.

The Reinsurance Ratio (RI): This parameter has an insignificant negative effect on turnover in the short run. A 1% increase in the reinsurance ratio leads to a 0.08% decrease in turnover. The insignificance of this effect signifies that reinsurance does not have a strong or direct short-term impact on insurance activity. This is likely because reinsurance decisions are typically made within a long-term strategic framework rather than as an immediate response to short-term fluctuations. Moreover, companies might utilize reinsurance as a flexible risk management tool without it causing an immediate, noticeable impact on turnover volume. From an analytical perspective, this short-term weakness can be linked to the fact that the effects of information asymmetry do not emerge entirely and instantaneously; rather, they accumulate gradually, making their impact on the structure of insurance activity far more evident in the long run than in the short run.

Conclusion

Heterogeneous Firm Response: The Fixed Effects Model reveals significant variations among Algerian insurers in managing information asymmetry; firms like CAAT, SAA, and CASH exhibit higher efficiency in underwriting and control, whereas CNMA, CARDIF, and GAM remain highly vulnerable.

Long-Run Negative Impact of the Loss Ratio: A 1% increase in the loss ratio (LR) structuralizes a 1.54% drop in long-term turnover . This stems from adverse selection and moral hazard, leading to accumulated claims that erode profitability over time.

Long-Run Negative Impact of Reinsurance: A 1% increase in the reinsurance ratio (RI) leads to a 0.28% decrease in long-term turnover . This hedging behavior transfers risk outward but shrinks domestic premium retention.
Insignificant Short-Run Effects: Both loss and reinsurance ratios show statistically insignificant impacts in the short run. This demonstrates that the consequences of information asymmetry are cumulative and take time to fully manifest.

Cross-Sectional Dependence: Testing confirms strong systemic interdependence across Algerian insurance companies, meaning financial shocks or fraud behavior in one firm dynamically affects others across the sector.

Recommendations and Future Perspectives

Enhancing Corporate Governance and Transparency: Vulnerable insurance companies (e.g., CNMA, CARDIF) must upgrade their internal information systems and enforce rigorous transparency to bridge the information gap with policyholders.

Establishing Specialized Behavioral Laboratories: It is highly recommended to support regulatory bodies and the "Alfa Agency" in founding research labs dedicated to studying behavioral economics and detecting the 50% of uninvestigated fraudulent insurance claims.

Adopting Dynamic and Fair Risk Pricing: Insurers should implement sophisticated exogenous and endogenous risk classification models to establish a sound foundation for policy pricing, effectively mitigating pre-contractual adverse selection.

Implementing Risk Bundling Strategies: Re-engineering insurance contracts to introduce mandatory group, family, or bundled coverages can serve as a primary defensive shield against opportunistic consumer behavior.

Transitioning to Long-Term Structural Risk Management: Rather than relying on temporary short-term fixes, management must deploy long-term strategic frameworks that balance risk-transfer via reinsurance with healthy internal premium retention.

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