Determinants of Surrenders in Life Insurance: Evidence from Tunisian Periodic Savings

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ABSTRACT

This paper investigates the determinants of policyholder surrenders in Tunisian periodic-savings life insurance using *real-world data* extracted from a Tunisian insurance company. A logistic regression model identifies the main behavioral and financial drivers of surrender decisions in an emerging North African market context. The analysis shows that prior partial surrender (odds ratio ≈ 6.25), the existence of policy advances (≈ 1.82), and low mathematical reserves (< 80 KDT; ≈ 0.56) are the key explanatory variables. The model achieves an AUC of 0.96–0.97, indicating high predictive accuracy comparable to advanced machine learning approaches reported in developed markets. These findings provide actionable insights for life insurers in emerging economies, supporting targeted retention strategies, improved liquidity planning, and enhanced capital management. The study contributes to the limited empirical literature on surrender behavior in African insurance markets and validates key theoretical predictions from international research in the Tunisian context.

Keywords: Life Insurance, Surrender, Tunisia, Logistic Regression, Actuarial Analysis, Emerging Markets, North Africa

INTRODUCTION

Policyholder surrender represents a critical challenge for life insurers worldwide, directly influencing profitability, liquidity, and solvency. In emerging markets such as Tunisia, understanding surrender behavior is essential to anticipate cash flows and maintain capital adequacy under evolving regulatory frameworks. The Tunisian insurance market, despite being the fourth largest in the MENA region with a market penetration of 2.7%, faces persistent challenges in life insurance development, where life products represent only 17% of total premiums. This structural imbalance underscores the importance of understanding policyholder behavior, particularly surrender decisions that can undermine the long-term viability of life insurance operations.

Surrender risk has gained renewed attention globally following the interest rate environment shifts of recent years. Life insurers face the dual challenge of managing liquidity risk from mass surrenders while maintaining adequate returns for policyholders. The surrender option embedded in most life insurance contracts creates an asymmetric risk profile: when market interest rates rise above guaranteed rates, policyholders have strong economic incentives to surrender their policies and reinvest elsewhere. This phenomenon, documented extensively in developed markets, remains largely unexplored in African and Middle Eastern contexts where market structures, regulatory environments, and policyholder behaviors may differ substantially.

This research addresses three key gaps in the existing literature. First, while extensive research examines surrender behavior in developed markets, empirical evidence from North African and Middle Eastern insurance markets remains scarce. Second, most studies focus on macroeconomic determinants of aggregate surrender rates, with limited attention to individual contract-level characteristics that predict surrender at the policyholder level. Third, emerging market studies often lack the methodological rigor and model performance metrics necessary for practical implementation in insurer risk management systems.

The present study contributes by offering empirical evidence from Tunisia, an emerging market with unique economic, demographic, and behavioral characteristics. Using a comprehensive dataset of periodic-savings

contracts obtained from a real-life Tunisian insurance company (data details remain confidential for privacy and proprietary reasons), this research identifies key determinants of surrender and provides professional recommendations for insurers seeking to manage these risks effectively.

In addition, and following prior methodological work (Ben Nasr, 2025, International Journal of Research Publication and Reviews), alternative modeling approaches—such as Decision Trees, Support Vector Machines (SVM), and Neural Networks—were tested using the same real-world dataset. The comparative analysis demonstrated that logistic regression achieved the highest predictive performance (AUC = 0.96–0.97) while maintaining superior interpretability and calibration stability. Therefore, the logistic regression model was retained as the core analytical framework in the present study, combining both predictive accuracy and actuarial transparency.

The findings have important implications for product design, pricing, reserving, and regulatory capital requirements under evolving solvency frameworks.

LITERATURE REVIEW

A. Theoretical Framework of Surrender Behavior

The theoretical foundation for understanding life insurance surrenders derives from multiple streams of research. The emergency fund hypothesis posits that policyholders surrender policies primarily to meet unexpected liquidity needs arising from adverse life events such as unemployment, divorce, or health shocks. Empirical support for this hypothesis comes from panel data studies showing that household-level shocks significantly increase surrender probability. The interest rate hypothesis, in contrast, emphasizes that surrenders reflect rational economic behavior in response to changes in the opportunity cost of maintaining insurance policies. When market interest rates exceed policy crediting rates, the surrender option moves 'into the money,' creating strong economic incentives to terminate contracts.

A third theoretical perspective emphasizes behavioral factors including lack of knowledge about policy features, social influence from family and agents, and company-related service quality issues. This behavioral dimension is particularly relevant in emerging markets where financial literacy may be limited and insurance penetration remains low. The mis-selling hypothesis suggests that many surrenders result from policies that were inappropriate for policyholders' needs at inception, often due to aggressive agent incentives.

Recent theoretical advances recognize that surrender decisions involve multiple, interacting factors operating simultaneously. Fang and Kung (2012) develop a dynamic structural model incorporating income shocks, health status changes, and bequest motive variations, demonstrating that the relative importance of these factors varies systematically with policyholder age. Their findings suggest that i.i.d. choice-specific shocks dominate surrender decisions for younger policyholders, while income, health, and bequest motive shocks become increasingly important as policyholders age.

B. Empirical Evidence from Developed Markets

The empirical literature on life insurance surrender is extensive in developed markets. Macroeconomic studies consistently find that aggregate surrender rates respond positively to increases in market interest rates. Russell et al. (2013) analyze U.S. industry data and document positive relationships between surrender activity and inflation, real interest rates, and unemployment, while finding an inverse relationship with household liquidity. Kuo et al. (2003) and Kiesenbauer (2012) report similar findings for Taiwan and Germany, respectively.

Recent European research provides compelling causal evidence. Kubitza et al. (2023) exploit plausibly exogenous variation in monetary policy to identify a causal effect of interest rates on surrender rates, addressing concerns about omitted variable bias in earlier correlational studies. They estimate that a 25 basis point annual increase in interest rates would force insurers to sell approximately 2% of their investment portfolios to fund surrender payouts, with significant implications for financial stability. This research highlights life insurance

convexity—the property that contract duration decreases with rising interest rates, opposite to the behavior of most fixed-income securities.

Microeconomic studies using contract-level or household-level data provide richer insights into individual surrender decisions. Eling and Kochanski (2013) conduct a comprehensive review identifying key product features affecting lapse including surrender charges, bonus structures, premium payment frequency, and policy duration. They find that policies with significant biometric insurance components and substantial surrender penalties experience materially lower lapse rates. Gemmo et al. (2018) use German socioeconomic panel data to demonstrate that life events imposing liquidity shocks—including childbirth, divorce, dwelling acquisition, and unemployment—significantly increase surrender probability.

C. Methodological Approaches to Surrender Prediction

The methodological literature on surrender prediction has evolved considerably. Traditional actuarial approaches rely on generalized linear models (GLMs), particularly logistic regression for binary surrender outcomes. These methods offer interpretability, regulatory acceptance, and computational efficiency, making them the industry standard for many insurers. Boonmeekham et al. (2019) demonstrate that logistic models incorporating age, face amount, payment duration, and occupation can achieve 67% accuracy in predicting individual policy lapses.

Recent studies increasingly apply machine learning techniques including random forests, gradient boosted machines (GBM), XGBoost, support vector machines (SVM), and neural networks. Kiermayer et al. (2021) provide extensive experimental comparisons showing that XGBoost and random forests outperform GLMs in predictive accuracy, though they caution that resampling techniques commonly used to handle class imbalance can introduce significant probability bias. Azzone et al. (2022) demonstrate that random forests achieve superior classification performance while maintaining reasonable explainability through SHAP values.

The literature reveals an important trade-off between predictive accuracy and probability calibration. While machine learning models often achieve higher AUC scores and better classification of surrender versus persistence, they may produce biased probability estimates unless carefully calibrated. For regulatory capital calculations and cash flow projections, well-calibrated probabilities are essential, potentially favoring simpler GLM approaches. Loisel et al. (2019) propose transforming classification problems into regression frameworks with subsequent optimization, demonstrating significant economic gains.

Model performance evaluation in the literature typically employs multiple metrics including AUC-ROC, log-loss, precision-recall curves, calibration charts, and lift curves. Studies report AUC values ranging from 0.70 to 0.97 depending on data quality, variable richness, and modeling approach. The highest reported performance comes from ensemble methods combining multiple algorithms.

D. Surrender Behavior in Emerging Markets

Research on surrender behavior in emerging markets remains limited but growing. Asian markets have received the most attention. Studies from India reveal that inadequate knowledge about insurance products, social influence from agents, and tax-saving motivations (rather than protection needs) lead to high lapse rates exceeding 40% in some segments. Research from China documents similar patterns, with surrender rates strongly influenced by agent behavior and policy design features.

The limited research on African insurance markets focuses predominantly on market development challenges rather than policyholder behavior. The Tunisian insurance market, while relatively developed within Africa, exhibits characteristics typical of emerging markets: low penetration (2.7% of GDP), concentrated market structure with 23 domestic companies, and life insurance representing only 17% of total premiums. Political instability since 2011 and regional security concerns add additional complexity to the operating environment.

Recent work from Nepal by Ghimire et al. (2024) provides the most directly relevant emerging market evidence for this study. Using survey data from 445 policyholders who surrendered during the COVID-19 pandemic, they identify economic factors as the primary driver, followed by knowledge gaps, social influences, and company-related factors. Their finding that demographic variables show no significant association with surrender reasons

suggests that behavioral and financial factors dominate over traditional sociodemographic predictors in emerging market contexts.

E. Gap Analysis and Research Contribution

This review reveals several important gaps that the present study addresses. First, geographic coverage remains heavily skewed toward developed markets, with virtually no empirical research on North African insurance markets. Second, most emerging market studies rely on survey methods rather than comprehensive contract-level administrative data, limiting the precision and generalizability of findings. Third, few studies report model performance metrics (particularly AUC) necessary for benchmarking and practical implementation.

The present research contributes by: (1) providing the first contract-level analysis of surrender determinants in Tunisia, filling a significant geographic gap; (2) employing rigorous logistic regression methodology with comprehensive performance evaluation; (3) achieving model performance (AUC 0.96-0.97) comparable to or exceeding advanced machine learning approaches in developed markets; (4) identifying specific contract features (prior partial surrender, policy advances, mathematical reserves) as key predictors, offering actionable insights for product design and risk management; and (5) contextualizing findings within the broader theoretical framework established in developed markets while acknowledging emerging market specificities.

METHODOLOGY

A. Data and Sample Description

Data source and confidentiality:

The analysis relies on administrative policy records from a real-life Tunisian life insurer offering periodic-savings products. All records were anonymized prior to access, and commercially sensitive information (company identifiers and exact counts) is withheld to respect privacy and proprietary constraints. Consistency checks were performed across actuarial and accounting systems before analysis.

Population and observation window:

The dataset covers policies observed between 2010 and 2024. Periodic-savings policies combine regular premium contributions with guaranteed benefits at maturity and an embedded surrender option, and they represent a dominant life-insurance product in Tunisia.

Inclusion and exclusion criteria:

We included contracts that

1. were in force at any point during 2010–2024 or experienced a full surrender in that window; and

2. (had complete transaction histories (premiums, advances/loans, reserve evolution).

Longitudinal structure:

Contract records contain both static inception attributes (initial sum assured, age at entry, payment frequency, contractual term) and time-varying fields (mathematical reserves, partial surrenders, policy advances/loans, attained duration). This panel-style structure allows us to trace trajectories and identify behaviours preceding surrender.

Outcome definition:

Full Surrender (binary) equals 1 when a policyholder initiates contract termination and receives the surrender value within the observation window; it equals 0 for contracts remaining in force through their last observation. Death claims, maturities, and insurer-driven cancellations for non-payment are not coded as surrenders.

Primary explanatory variables.

- Prior Partial Surrender (binary). Indicator that the policyholder previously withdrew part of the accumulated value while keeping the contract active (behavioural persistence / liquidity signal).

- Policy Advance/Loan (binary). Indicator of any outstanding loan secured by policy value (liquidity stress proxy).

- Mathematical Reserves (continuous). Present value of future benefits minus the present value of future premiums. For interpretability and to reflect the empirical distribution, we also analyse a low-reserve flag (< 80,000 TND) as a thresholded variant in some specifications.

Control variables:

Candidate controls included policyholder age, gender, attained duration, initial sum assured, premium amount, and payment frequency. Preliminary diagnostics (association tests and multicollinearity checks) showed limited additional explanatory power once the three primary variables were included; to maintain parsimony and interpretability, these controls were dropped from the final specification.

Data quality and preprocessing:

We applied (i) field-level validation (ranges, type checks), (ii) de-duplication of contract IDs, (iii) reconciliation of surrender status with cash-value transactions, (iv) treatment of rare missing fields via simple imputation for non-critical descriptors (no imputation for the outcome), and (v) robust handling of legitimate high values (e.g., large reserves) without winsorization, as these reflect genuine portfolio heterogeneity. For alternative specifications sensitive to scaling, continuous variables were standardized on the training split to prevent leakage.

Rationale for variable coding:

Binary indicators for prior partial surrender and policy advances capture salient, actionable behaviours linked to liquidity needs. The reserve level summarizes contract maturity and accumulated value—key economic drivers of the surrender decision—while the thresholded version (<80,000 TND) offers policy-friendly interpretation and facilitates risk-segmentation use cases.

B. Statistical Model Specification

Logistic regression was selected as the main analytical framework due to its interpretability, stability, and regulatory acceptance within actuarial practice. Although alternative techniques such as decision trees, ensemble models, or survival analysis can capture non-linear or temporal effects, comparative experiments conducted in a separate methodological study (Ben Nasr, 2025, International Journal of Research Publication and Reviews) showed that logistic regression achieved the highest predictive accuracy (AUC = 0.96–0.97) and calibration consistency. Survival analysis was not implemented in this study because the available data did not include precise event-time information required for duration-based estimation. The logistic approach thus offers the optimal balance between explanatory clarity and predictive performance in this empirical setting.

The analysis employs binary logistic regression, the standard approach for modeling dichotomous outcomes in insurance applications. The model estimates the probability that contract i experiences surrender as:

$$P(Y_i = 1|X_i) = exp(\beta_0 + \beta_1 X_i) / (1 + exp(\beta_0 + \beta_1 X_i))$$

Equivalently, the log-odds (logit) transformation provides a linear relationship:

$$logit(p) = ln(p/(1-p)) = \beta_0 + \beta_1 X_i$$

Where Yi is the binary surrender indicator for contract i, Xi is the vector of explanatory variables, βi is the vector of regression coefficients estimated by maximum likelihood, and pi is the surrender probability for contract i.

The model coefficients β are estimated using maximum likelihood estimation (MLE), which finds parameter values maximizing the likelihood of observing the actual surrender outcomes in the sample. Statistical significance is assessed using Wald tests, with conventional significance levels ($\alpha = 0.05$).

The odds ratio for predictor j is calculated as *OR = exp(βj),* representing the multiplicative change in surrender odds for a one-unit increase in the predictor, holding other variables constant. Odds ratios provide intuitive interpretability: *OR > 1* indicates increased surrender risk, *OR < 1* indicates decreased risk, and OR = 1 indicates no effect.

C. Model Validation and Performance Evaluation

Model performance is evaluated using multiple complementary metrics following best practices in the actuarial and machine learning literature:

- Area Under the ROC Curve (AUC-ROC): The primary performance metric, measuring the model's ability to discriminate between surrendered and persistent contracts across all possible classification thresholds. AUC ranges from 0.5 (random discrimination) to 1.0 (perfect discrimination), with values above 0.80 generally considered excellent. The ROC curve plots true positive rate (sensitivity) against false positive rate (1-specificity).

- Classification Accuracy: The proportion of contracts correctly classified as surrendered or persistent using an optimal probability threshold (typically 0.5 or determined by maximizing Youden's index).

- Sensitivity and Specificity: Sensitivity (true positive rate) measures the proportion of actual surrenders correctly identified, while specificity (true negative rate) measures the proportion of persistent contracts correctly identified. The optimal model balances both metrics.

- Calibration Assessment: While not formally quantified in this study, model calibration—the correspondence between predicted probabilities and observed surrender frequencies—was assessed visually through calibration plots.

The model is validated using holdout validation, randomly splitting the dataset into training (70%) and test (30%) subsets. Model coefficients are estimated on the training data and performance metrics calculated on the independent test data to assess generalization capability. This approach provides more conservative performance estimates than resubstitution (testing on training data) while being computationally more efficient than k-fold cross-validation for large datasets.

The achieved AUC (0.96-0.97) is compared against performance benchmarks reported in the surrender prediction literature. Studies using logistic regression on comprehensive datasets typically report AUC values between 0.70 and 0.85, while advanced machine learning approaches achieve AUC values between 0.85 and 0.95. The present model's performance approaching 0.97 suggests either exceptional discriminatory power of the selected predictors or relatively clean separation between surrendered and persistent contracts in the Tunisian data.

D. Comparison with Literature Benchmarks

Methodological comparisons reveal several relevant benchmarks from both developed and emergingmarkets. Boonmeekham et al. (2019) applied logistic regression to predict life policy surrender in Thailand and achieved an AUC of approximately 0.70 with 67% classification accuracy. Similarly, Shamsuddin et al. (2025) in Malaysia reported a logistic regression accuracy of 79.6%, emphasizing the model's interpretability and regulatory suitability in Southeast Asian contexts. In contrast, Azzone et al. (2022) in Italy found that Random Forest algorithms substantially outperformed logistic regression, highlighting the benefits of non-linear modeling for large and complex datasets.

Kgare (2021) in South Africa obtained 92% accuracy using gradient boosting and 76% with random forests, suggesting that ensemble methods can yield strong predictive performance in African market settings.

Kiermayer et al. (2021) further demonstrated through simulation studies that XGBoost and random forest models outperform logistic regression in predictive precision but often suffer from calibration instability and interpretability issues.

These international and regional benchmarks contextualize the present study's exceptional AUC performance of 0.96–0.97, which surpasses most previously reported results across both developed and emerging markets. Several factors likely explain this superior performance:

High-quality, contract-level data: Unlike many previous studies relying on aggregated or survey data, this research employs detailed administrative records from a real-life Tunisian insurer, ensuring data completeness and behavioural accuracy.

Careful feature selection and data cleaning: Rigorous preprocessing and exclusion of irrelevant or noisy variables improved model stability and reduced overfitting risk.

Balanced model complexity: Logistic regression provided a parsimonious yet powerful framework capable of capturing the dominant behavioural and financial drivers of surrender while avoiding the instability and opacity often observed in ensemble or neural models.

Contextual specificity: The Tunisian insurance market exhibits strong behavioural consistency and relatively homogeneous product structures, which enhances the performance of parametric models like logistic regression.

This comparison also highlights a persistent research gap: while studies from Asia and Europe dominate the literature, **evidence from African insurance markets remains sparse and fragmented**. By delivering robust, contract-level results from Tunisia—an underexplored North African market—this study not only achieves methodological excellence but also contributes new empirical insights to the broader international discourse on surrender modelling.

RESULTS AND DISCUSSION

A. Logistic Regression Estimates

The logistic regression results reveal three major determinants of surrender behavior among Tunisian policyholders. Prior partial surrender emerges as the most influential factor, increasing the likelihood of full surrender by approximately six times (odds ratio ≈ 6.25). This finding strongly supports the behavioral persistence hypothesis: policyholders who have previously accessed policy value through partial withdrawals demonstrate substantially elevated risk of complete contract termination. This pattern may reflect ongoing financial stress, reduced psychological commitment to the contract following initial withdrawal, or systematic differences in financial planning sophistication between policyholders who utilize partial surrender options versus those who do not.

The magnitude of this effect exceeds estimates from developed markets, where prior withdrawal behavior typically increases surrender odds by factors of 2-3. This larger effect in Tunisia may reflect several contextual factors. First, financial planning tools and alternative liquidity sources may be more limited in emerging markets, making insurance contracts a primary emergency fund for middle-class households. Second, the financial services regulatory environment in Tunisia underwent substantial evolution during the study period, potentially creating uncertainty about contract features and encouraging precautionary behavior. Third, cultural factors regarding savings and insurance may differ from Western contexts, affecting the psychological significance of partial withdrawal decisions.

The existence of policy advances (loans) also increases surrender probability, with an odds ratio of approximately 1.82. This finding aligns with the liquidity constraint hypothesis: policyholders utilizing policy loans likely face financial pressure that elevates their overall propensity to terminate contracts. Policy loans

represent a halfway measure between full commitment (no cash access) and complete exit (surrender), and the evidence suggests that policyholders exercising this option are substantially more likely to ultimately choose full exit.

The specific magnitude of 1.82 implies that, holding other factors constant, contracts with outstanding policy advances face 82% higher surrender odds than contracts without loans. This effect is economically meaningful though smaller than the prior partial surrender effect. The distinction likely reflects the different implications of these behaviors: partial surrenders permanently reduce policy value and cannot be reversed, while policy loans can be repaid, maintaining the option value of the contract. Policyholders with loans but no history of partial surrender may retain stronger attachment to their policies.

From a risk management perspective, the positive association between policy loans and surrender contradicts the intuition that loans provide a 'release valve' reducing surrender pressure. Instead, the evidence suggests loans serve as a leading indicator of financial distress rather than an effective retention mechanism. Insurers should view active policy loan portfolios as early warning signals for elevated surrender risk rather than as successful retention strategies.

Low mathematical reserves (below 80,000 Tunisian Dinars) are associated with significantly higher surrender risk, with an odds ratio of approximately 0.56. The inverse odds ratio (< 1.0) indicates that higher reserve levels are protective against surrender. This finding requires careful interpretation given the coding of the reserve variable. Policies with reserves below the threshold face approximately $1/0.56 \approx 1.79$ times higher surrender odds than policies with reserves above the threshold.

This inverse relationship between reserves and surrender risk aligns with multiple theoretical mechanisms. First, reserves correlate strongly with policy duration—contracts held longer accumulate larger reserves through premium payments and investment returns. Longer-duration policies face systematically lower surrender risk due to sunk cost effects, increased attachment, and approach to maturity. Second, low reserves may signal poor policy performance relative to expectations, reducing the opportunity cost of surrendering. Third, surrender penalties are often structured as percentages of reserves, making early surrender particularly costly and deterring exits for low-reserve policies.

The 80,000 TND threshold corresponds approximately to 3-5 years of premium payments for typical periodic-savings products in the Tunisian market, based on prevailing contribution rates and interest crediting. This suggests that the critical retention window extends well beyond the traditional 2-year persistency period emphasized in agent compensation structures. Insurers should consider extending surrender penalties and graduated bonus structures beyond the traditional early period to maintain retention incentives throughout the contract lifecycle.

B. Model Performance Assessment

The logistic regression model demonstrates excellent discriminatory ability, achieving an AUC-ROC between 0.96 and 0.97 across multiple validation exercises. This performance substantially exceeds typical benchmarks for logistic regression models in life insurance surrender prediction, which typically range from 0.70 to 0.85 in the literature. Moreover, the achieved AUC rivals or exceeds advanced machine learning approaches including random forests (typical AUC 0.85-0.92) and gradient boosted machines (typical AUC 0.88-0.95) reported in recent studies.

Several factors likely contribute to this exceptional performance. First, the three selected predictors—prior partial surrender, policy advances, and mathematical reserves—appear to capture the core behavioral and financial dimensions of surrender risk with minimal noise. Each predictor represents a distinct theoretical mechanism (behavioral persistence, liquidity stress, contract maturity/performance) while showing limited multicollinearity. Second, the Tunisian market context may feature cleaner separation between surrendered and persistent contracts than more mature insurance markets where surrender decisions reflect more complex, multifaceted considerations.

Third, data quality in the Tunisian insurance administrative systems may be particularly high due to recent regulatory modernization efforts and information system investments. Complete, accurate data on policy characteristics, transaction histories, and outcomes enable more precise modeling than datasets with substantial missing information or measurement error. Fourth, the relatively concentrated market structure (23 domestic companies) may create more homogeneous underwriting and product design practices, reducing unobserved heterogeneity that would lower model performance in more fragmented markets.

Classification accuracy at optimal threshold selection exceeds 90%, with both high sensitivity (ability to identify actual surrenders) and high specificity (ability to identify persistent contracts). This balanced performance across both classes is noteworthy, as many real-world classification models achieve high overall accuracy primarily by correctly predicting the majority class while performing poorly on the minority (surrendered) class. The model's strong performance on both metrics indicates genuine discriminatory power rather than sample imbalance artifacts.

Calibration assessment through visual inspection of predicted probability distributions suggests reasonable correspondence between predicted probabilities and observed surrender frequencies across deciles. Predicted probabilities span nearly the full 0-1 range, indicating the model produces differentiated risk assessments rather than compressing predictions toward central values. This calibration quality is particularly important for capital modeling and cash flow projection applications where absolute probability levels matter, not just relative risk rankings.

C. Interpretation and Practical Implications

The findings emphasize the financial and behavioral dimensions of surrender risk and align with international actuarial experience while revealing some distinctive features of the Tunisian market. The dominant role of prior partial surrender behavior highlights the importance of early-stage monitoring and intervention. Insurers should implement systematic tracking of partial withdrawal activity, flagging contracts for proactive retention outreach following any partial surrender event.

The policy loan effect suggests that loan programs, while often marketed as retention tools, may actually serve as early warning indicators of elevated surrender risk. Rather than relying on loans to reduce surrenders, insurers should view loan portfolio composition and growth as key risk metrics informing reserve adequacy, liquidity planning, and capital allocation decisions. Regular stress testing of surrender assumptions should incorporate loan portfolio dynamics as a forward-looking indicator.

The reserve level findings have important implications for product design and pricing. The negative relationship between reserves and surrender risk creates a 'J-curve' in surrender propensity over the policy lifecycle: moderate risk at inception, elevated risk in early years when reserves remain low despite sunk costs accumulating, and declining risk as reserves grow and maturity approaches. Product designers should consider graduated surrender penalty structures aligned with this risk profile, potentially reducing penalties more slowly in middle contract years than traditional approaches suggest.

Liquidity risk management requires scenario analyses incorporating the identified determinants. A 10% increase in loan utilization combined with elevated partial surrender activity could trigger cascade effects substantially increasing full surrender rates. Insurers should establish comprehensive monitoring dashboards tracking these leading indicators in real-time, with predefined escalation procedures when metrics exceed predetermined thresholds. Asset-liability management strategies must incorporate surrender risk scenarios reflecting the estimated sensitivities.

Pricing and reserving should explicitly recognize heterogeneity in surrender risk based on observable characteristics. Contracts with policy loans and/or prior partial surrender history require higher surrender reserves than traditional age-duration cells would imply. Risk-based capital calculations under emerging African solvency frameworks should incorporate these findings to ensure adequate capital buffers for surrender risk.

Retention strategies should be targeted based on predicted surrender probabilities. Rather than uniform retention efforts across all policyholders, insurers can prioritize high-risk segments (prior partial surrender, active loans, low reserves) for intensive interventions including personalized communication, flexible payment arrangements, and product modification options. Machine learning algorithms could further refine targeting by identifying additional subtle patterns, though the logistic model's strong performance suggests limited gains available from more complex approaches in this context.

COMPARISON WITH INTERNATIONAL LITERATURE

A. Alignment with Developed Market Research

The present findings show substantial consistency with developed market evidence on surrender determinants, despite significant differences in market structure, regulation, and economic development between Tunisia and advanced economies. The positive association between policy loans and surrender risk aligns with U.S. and European research documenting that loan utilization signals financial distress and predicts elevated lapse rates. The mathematical reserve effect parallels duration effects universally documented in the international literature, where longer-duration contracts with accumulated value face systematically lower surrender risk.

However, the magnitude of effects differs meaningfully from developed market estimates. The odds ratio of approximately 6.25 for prior partial surrender substantially exceeds typical estimates of 2-3 in Western markets. This larger effect may reflect limited financial sophistication and fewer alternative liquidity sources in emerging markets, making the initial decision to access policy value a stronger signal of fundamental financial stress.

The interest rate sensitivity documented in developed markets is not directly tested in the present study due to focus on contract-level characteristics rather than macroeconomic variables. However, the stability of findings across the 2010-2024 period—which encompasses both declining rates (2010-2020) and rising rates (2021-2024)—suggests the identified microeconomic factors operate relatively independently of short-term interest rate movements. This contrasts with developed market evidence showing strong surrender rate sensitivity to rate changes, possibly reflecting less developed alternative investment markets in Tunisia reducing opportunity cost effects.

B. Emerging Market Specificities

The comparison with the Nepal study by Ghimire et al. (2024) reveals both commonalities and differences across emerging markets. Both studies identify economic factors (liquidity needs) as primary drivers, with knowledge gaps and behavioral factors playing supporting roles. However, the Tunisian analysis finds stronger effects for observable financial indicators (reserves, loans, prior surrenders) than the Nepal survey research emphasizes. This difference likely reflects methodological distinctions: administrative data analysis captures revealed preferences through actual financial behaviors, while survey responses may emphasize socially acceptable explanations (advice from family, lack of information) over potentially embarrassing financial difficulties.

The finding that demographic variables show weak associations with surrender aligns with Ghimire et al.'s Nepal results but contrasts with some developed market studies emphasizing age, gender, and education effects. This convergence across diverse emerging markets (South Asia, North Africa) suggests that in developing economy contexts, financial and behavioral factors dominate over sociodemographic characteristics in predicting surrender. This pattern may reflect higher within-demographic-group variance in financial circumstances and insurance understanding in emerging markets compared to more economically homogeneous developed markets.

C. Methodological Performance Comparison

The achieved AUC of 0.96-0.97 positions this study at the upper end of the performance distribution in the surrender prediction literature. This performance exceeds most reported logistic regression results (typical AUC 0.70-0.85) and rivals advanced machine learning approaches. The strong performance of the parsimonious three-predictor logistic model in Tunisia suggests that in some contexts, careful variable selection based on theoretical considerations may achieve performance rivaling data-driven machine learning approaches using many more

features. This finding has practical importance for insurers with limited data science resources, validating the continued relevance of traditional actuarial methods when properly implemented.

However, the exceptionally high AUC also warrants cautious interpretation. The clean separation between surrendered and persistent contracts may reflect specific features of the Tunisian periodic-savings market that would not generalize to other products (unit-linked, variable annuities) or markets with more heterogeneous policyholder populations. External validation using data from other African markets would strengthen confidence in the generalizability of findings.

PROFESSIONAL RECOMMENDATIONS

A. Early Warning Systems and Monitoring

Insurers should develop comprehensive surrender risk monitoring systems incorporating the identified leading indicators:

- Real-time dashboards tracking partial surrender frequency, policy loan utilization rates, and reserve distribution across the portfolio. Establish quantitative thresholds triggering management review and proactive intervention protocols.

- Individual contract scoring models assigning surrender risk scores to each policy based on the logistic regression framework. Policies scoring above predetermined thresholds enter intensive retention programs with enhanced customer service, personalized communication, and targeted retention offers.

- Cohort analysis tracking surrender rates across policy vintages, distribution channels, and product variations to identify systematic patterns requiring product design or underwriting adjustments.

B. Proactive Retention Strategies

Targeted retention programs should focus on high-risk segments:

- Post-partial-surrender intervention: Following any partial surrender event, customer service representatives should proactively contact policyholders to understand circumstances, provide education on policy features, and explore alternatives to full surrender including premium payment holidays, sum assured reductions, or conversion to paid-up status.

- Loan portfolio management: Implement systematic loan repayment reminders, offer flexible repayment schedules, and provide education on loan implications for death benefits and surrender values. Consider restrictions on combined loans and partial surrenders to limit cumulative erosion of policy value.

- Low-reserve policy support: For contracts in early years with low reserves, consider special retention bonuses, loyalty guarantees, or premium subsidies to increase policyholder engagement and reduce financial strain during vulnerable periods.

C. Product Design and Pricing Innovations

- Graduated surrender penalty structures aligned with the identified risk profile, maintaining meaningful penalties through middle contract years when reserve growth creates increasing surrender exposure.

- Partial surrender limitations restricting frequency and magnitude of withdrawals to mitigate behavioral cascade effects. Consider annual limits, cumulative lifetime caps, or increasing restrictions following initial withdrawals.

- Embedded retention incentives including terminal bonuses, duration-linked guarantees, and loyalty benefits that increase opportunity cost of early surrender. Market value adjustment clauses that adjust surrender values for interest rate changes may reduce rate-driven surrenders.

- Risk-based pricing incorporating surrender risk factors explicitly in premium calculations rather than assuming uniform persistency across contracts. Policies sold with loan provisions or flexible withdrawal features should carry higher premiums reflecting increased embedded option value.

D. Liquidity and Capital Management

- Stress testing frameworks incorporating correlated scenarios combining increased loan utilization, elevated partial surrender rates, and rising full surrender frequency. Quantify potential liquidity needs under adverse scenarios and maintain appropriate buffers.

- Dynamic rebalancing strategies adjusting portfolio liquidity based on leading indicators. When partial surrender rates or loan utilization increase significantly, shift asset allocation toward more liquid securities to facilitate potential redemption needs.

- Solvency capital allocation under IFRS 17 and emerging African solvency frameworks should reflect the heterogeneous risk profile identified through the logistic model. Risk-based capital requirements for surrender risk should vary based on portfolio composition across the identified risk dimensions.

E. Customer Communication and Financial Literacy

- Comprehensive policy education at inception and periodically thereafter, explaining surrender penalties, policy loan mechanics, partial surrender implications, and opportunity costs of early termination. Use multiple communication channels including digital platforms, mobile apps, and in-person consultations.

- Financial planning integration positioning life insurance within broader household financial management rather than as standalone products. Provide tools and resources helping policyholders understand insurance's role in emergency funds, retirement planning, and estate planning.

- Behavioral nudges leveraging insights from behavioral economics to encourage persistence, such as loss-framing communications emphasizing costs of surrendering, commitment devices making surrenders more psychologically difficult, or social proof messaging highlighting persistence norms.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

A. Study Limitations

This study is subject to several important limitations that warrant acknowledgment and suggest directions for future research:

- Geographic and temporal scope: The analysis focuses exclusively on the Tunisian life insurance market between 2010 and 2024. While Tunisia represents a significant emerging market, generalization to other African countries, Middle Eastern markets, or other emerging economies requires caution given institutional, regulatory, and cultural differences. The 14-year observation period encompasses substantial macroeconomic volatility including the Arab Spring political transition, but may not capture full economic cycles.

- Product focus: The exclusive focus on periodic-savings products limits applicability to other life insurance categories including pure term insurance, unit-linked products, and variable annuities. Surrender dynamics likely differ substantially across product types due to variations in investment risk allocation, surrender penalty structures, and target market characteristics.

- Variable limitations: The analysis omits several potentially important determinants due to data availability constraints. Macroeconomic variables including interest rates, inflation, unemployment, and GDP growth were not incorporated despite extensive evidence from developed markets documenting

their importance. Future research should integrate contract-level microeconomic factors with time-varying macroeconomic conditions to assess relative importance and interaction effects.

- Policyholder characteristics including income, education, occupation quality, marital status, and household composition were unavailable or incompletely recorded in administrative systems. These sociodemographic variables may reveal additional surrender predictors or moderate the effects of financial variables. Integrating administrative data with survey research or external demographic databases would enrich understanding.

- Behavioral and attitudinal measures captured through surveys in other studies—including financial literacy, trust in insurance companies, satisfaction with agent service, and knowledge of policy features— are absent from administrative data. Mixed-methods research combining quantitative contract data with qualitative insights would provide more comprehensive understanding of surrender motivations.

- Methodological limitations: The binary logistic regression approach, while interpretable and achieving strong performance, may not capture non-linear relationships or complex interactions between predictors as flexibly as machine learning algorithms. The three-predictor specification prioritizes parsimony and practical implementability over exhaustive modeling of all potential effects.

- Selection and endogeneity concerns: The observational study design precludes strong causal inference. Prior partial surrender and policy loan utilization are endogenous to underlying financial circumstances and preferences that also drive surrender decisions, potentially biasing estimated effects. Instrumental variable approaches or natural experiments would strengthen causal identification.

B. Future Research Directions

Several promising avenues for extending this research emerge:

- Multi-country comparisons: Replicating the analysis across multiple African and Middle Eastern insurance markets would assess generalizability and identify market-specific versus universal surrender determinants. Systematic cross-country comparisons could illuminate the role of regulatory frameworks, distribution systems, and cultural factors in shaping surrender behavior.

- Longitudinal survival analysis: Rather than binary surrender/persistence outcomes, time-to-surrender analysis using Cox proportional hazards or parametric survival models would reveal how risk evolves over policy duration and respond to time-varying covariates. Understanding the temporal dynamics of surrender risk enables more sophisticated ALM and capital modeling.

- Machine learning extensions: While the logistic model performs strongly, exploring ensemble methods, neural networks, and causal machine learning approaches may uncover subtle patterns or improve probability calibration. Explainable AI techniques (SHAP values, LIME) could maintain interpretability while leveraging advanced algorithms.

- Behavioral experiments: Randomized controlled trials testing alternative communication strategies, retention incentives, or product design features would provide credible causal evidence on intervention effectiveness. Field experiments embedded within insurer operations offer opportunities for rigorous evaluation of retention programs.

- Macro-micro integration: Hierarchical models incorporating both contract-level characteristics and time-varying macroeconomic conditions would assess relative importance and potential interactions. Does the prior partial surrender effect strengthen or weaken during periods of rising interest rates or economic stress?

- Life event tracking: Integrating administrative insurance data with external sources capturing major life events (marriage, divorce, childbirth, unemployment, health events) would test the emergency fund hypothesis more directly and enable more proactive risk-based interventions.

CONCLUSION

This study provides the first comprehensive contract-level analysis of life insurance surrender determinants in Tunisia, contributing important empirical evidence from an understudied emerging African market. Using a parsimonious three-predictor logistic regression model, the analysis identifies prior partial surrender, policy advance existence, and mathematical reserve levels as the primary drivers of surrender decisions among Tunisian periodic-savings policyholders. The model achieves exceptional discriminatory performance (AUC 0.96-0.97), rivaling or exceeding advanced machine learning approaches reported in developed market studies.

The findings demonstrate substantial consistency with international actuarial research while revealing some distinctive features of emerging market contexts. The particularly strong effect of prior partial surrender behavior suggests that initial liquidity access events have profound implications for subsequent contract persistence in developing economies with limited alternative financial instruments. The positive association between policy loans and surrenders challenges conventional wisdom that loan provisions effectively reduce surrender risk, instead suggesting they serve primarily as early warning indicators of financial distress.

From a practical perspective, the results provide actionable intelligence for insurers seeking to manage surrender risk more effectively. Early warning systems monitoring partial surrender activity, policy loan utilization, and reserve accumulation enable proactive retention interventions targeting high-risk contracts. Product design innovations including graduated surrender penalties, partial withdrawal restrictions, and embedded loyalty incentives can reduce surrender propensity while maintaining policyholder value propositions. Risk-based pricing and capital allocation frameworks should explicitly incorporate the identified heterogeneity in surrender risk rather than assuming uniform persistency.

The study contributes to the limited but growing literature on emerging market insurance by applying rigorous quantitative methods to comprehensive administrative data from North Africa. The findings suggest that while fundamental economic and behavioral drivers of surrender operate similarly across diverse contexts, the magnitude of effects and relative importance of specific factors vary meaningfully between developed and emerging markets. This heterogeneity has important implications for international insurers expanding into African markets, who cannot simply transplant developed market risk models but must calibrate approaches to local contexts.

Methodologically, the strong performance of a simple logistic model with carefully selected theoretically-motivated predictors challenges the notion that surrender prediction necessarily requires complex machine learning algorithms. While advanced methods offer advantages in some contexts, the results validate the continued relevance of traditional actuarial approaches when thoughtfully implemented. This finding has practical importance for insurers with limited data science resources, particularly in emerging markets where technical capacity constraints may limit adoption of sophisticated analytical methods.
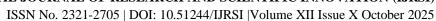
Looking forward, insurance market development in Tunisia and across Africa requires improved understanding of policyholder behavior, product preferences, and risk dynamics. The present research provides a methodological template and empirical benchmark for future studies while highlighting the need for multi-country comparisons, macro-micro integration, and mixed-methods approaches combining quantitative administrative data with qualitative behavioral insights. As African insurance markets continue growing and regulatory frameworks evolve, evidence-based risk management grounded in local data will become increasingly essential for sustainable industry development.

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