Appendix 1 : Summary of the Early-Warning Sovereign Debt Literature

Authors	Country	Crisis type	Methodology	Main findings
Kaminsky, Lizondo & Reinhart (1998)	20 countries	Currency crises (EWS foundation)	Signals approach (threshold-based model)	Currency crises are preceded by identifiable macro-financial imbalances. The strongest predictors are real exchange rate overvaluation, reserve losses, rapid credit growth, high M2/reserves ratio, and rising real interest rates. Combining indicators improves predictive performance compared to single-variable signals.
Manasse & Roubini (2009)	47 countries	Sovereign debt crises	Logit model + Classification and Regression Tree (CART)	Sovereign debt crises are more likely when public debt is high and growth is low. Debt above ~50% of GDP combined with weak growth or high external vulnerability sharply increases default probability. Non-linear interactions between debt, growth, and external factors are crucial.
Candelon, Dumitrescu & Hurlin (2012)	40 countries	Early-warning model evaluation framework	Logit/Probit; decision trees; signal models	Early warning models must be evaluated using a loss function reflecting policymakers' preferences. Standard accuracy measures are insufficient; the "Usefulness" criterion provides a coherent way to compare crisis prediction models in-sample and out-of-sample.
Fuertes, Kalotychou & Saka (2015)	66 countries	Sovereign debt crises	Panel logit model	Higher public debt and weak growth increase default risk, while strong fiscal balances and better institutional quality significantly reduce it. Fiscal discipline and institutional strength are key in preventing sovereign debt crises.
Cerovic et al. (2018, IMF)	80/90 countries	Fiscal crises	Panel logit early warning model	Higher public debt, weak fiscal balances, low growth and tighter global financial conditions significantly increase sovereign stress risk. Fiscal sustainability indicators are central in predicting episodes of sovereign distress.
Bruns & Poghosyan (2016, IMF)	68 countries	Fiscal distress	Logit model + Extreme Bound Analysis (EBA)	High public debt, weak growth, and deteriorating fiscal balances significantly increase sovereign crisis probability. Global financial conditions and external vulnerabilities also play an important predictive role.
Berti, Salto & Lequien (2012, EC)	EU countries (27)	Fiscal stress in the EU	Non-parametric signals approach + Logit model	High public debt, weak growth, external imbalances, and loss of competitiveness significantly increase fiscal stress risk in EU countries. Market indicators and macro fundamentals jointly improve stress prediction.
Jarmulska (2020, ECB)	EU countries	Fiscal stress in the Euro Area	Logit vs Random Forest comparison	High public debt, weak growth, rising borrowing costs and adverse global financial conditions significantly increase fiscal stress risk in advanced economies.

Fuertes & Kalotychou (Int. J. Forecasting, 2007)	30 countries	Sovereign debt crises	Early Warning System design with loss function; forecast combination techniques (logit / clustering methods)	Debt levels, growth, and external vulnerability significantly predict sovereign crises. The choice of classification threshold critically affects predictive performance and should reflect policymakers' loss preferences.
Baldacci et al. (IMF WP/11/100, 2011)	50 countries	Fiscal stress / near-default (index)	Construction of a Fiscal Stress Index (signal-based aggregation framework)	High public debt, large gross financing needs, weak growth, and adverse global financial conditions significantly increase fiscal stress risk. Gross financing needs emerge as a key leading indicator.
Hernández de Cos et al. (ECB WP 1712, 2014)	12-17 countries	Fiscal stress (zone euro)	Panel logit model with country-specific thresholds	High public debt, weak growth, external imbalances and rising borrowing costs significantly increase fiscal stress risk in euro area countries. Predictive performance improves when accounting for country-specific characteristics.
Babecký et al. (ECB WP 1486, 2012)	40 countries	Banking, sovereign and currency crisis	Early warning framework (logit models, signal approach, and indicator-based analysis)	Rapid credit growth, asset price booms, rising public debt and external imbalances significantly increase crisis probability. Indicators differ across crisis types, highlighting the importance of tailored early warning models.
Hellwig (IMF WP/21/150, 2021)	20-30 countries	Fiscal crises	Machine learning methods (elastic net logit, random forest, XGBoost, etc.) with comparative evaluation	High public debt, rising borrowing costs, weak growth and tightening global financial conditions significantly increase the probability of fiscal crises in advanced economies.