A Review and Bibliography of Early Warning Models

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Abstract

This note is intended to share some observations regarding a non-exhaustive collection of the early warning literature from 1971 to 2011. Evolution of the interest in early warning models, methodological spectrum of studies and coverage of economic variables are briefly discussed in addition to providing a bibliography.

JEL Classification: C00, Z00.

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Early warning models in economics and finance have always been of some non-negligible level of interest. A large portion of this interest and the motivation to build early warning models/systems in economics and finance can be attributed to performance of the early warning models/systems in the domain of engineering. However, the word *performance* in the previous sentence can comfortably be replaced with the word *fanciness*.

This note is intended to share some observations regarding a non-exhaustive collection of the early warning literature from 1971 to 2011. Evolution of the interest in early warning models, methodological spectrum and coverage of economic variables are briefly discussed in addition to providing a bibliography of early warning models. It must be noted that the background material of this note, composed of approximately 150 papers, was collected as part of the literature survey for another project, so this note has been delivered as a by-product. Approximately 56% of the examined papers are directly/closely related to early warning with an average publication year of 1996. The remaining 44% are indirectly related to early warning with an average publication year of 1999 yet provide good insight regarding the early warning models/systems.

Figure 1. Number of Studies against Time
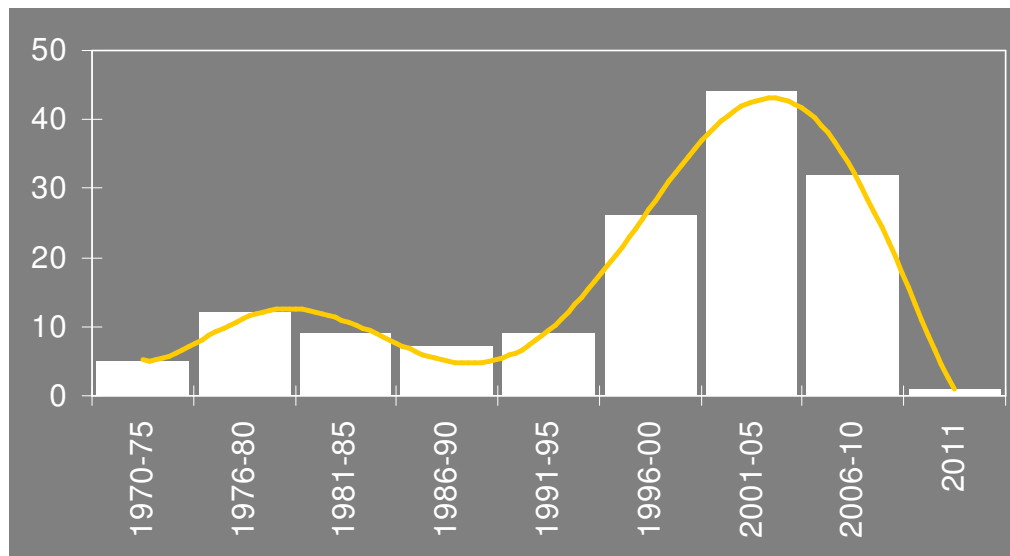
Notes Simple counts. See the Bibliography section as well as Appendix-Table A1 for details.

Interest in early warning models seem to increased after mid-1990s, had its climax between 2001 and 2005 and slightly decreased during the half decade following that (Figure 1). It is not surprising to observe the increase after 1996 as the 1990s mark a critical episode of globalization which resulted in elevated levels of sovereign states' financial fragility. Equivalently, a broader spectrum of risks has required new, richer and sophisticated mechanisms/models of surveillance.

As far as the methodologies are concerned (Table 1), binary dependent variable family of models seem to have been the most popular. Individually, the logit analysis is the first (21 out of 124), signal extraction analysis and discriminant/factor analysis share the second place (14 out of 124 each).

Table 1. Popularity of Methodologies in Early Warning Studies

Methodology	Count	Subtotal	Methodology	Count	Subtotal
ARMA	2		Artificial Neural Networks	2	2
Forecasts&combinations	4				
Regression (p/np)	8		Exchange market pressure index	4	
VAR&simultaneous equations	2		Indicators&indices	6	10
VARMA-GARCH	1	17			
			Markov-switching	6	6
Burrit	1				
Linear probability model	1		Bayesian belief revision	1	1
Logit	21				
Lomit	1		Simulation	1	
Probit	7	31	Value-at-Risk	2	3
Analytical hierarchy process	1		CAAMPL	1	
Binary recursive tree	1		CAMEL	2	
Clustering	2		Catastrophe	1	
Diffusion index	2		Damocles (Lehman Brothers)	1	
Discriminant analysis	12		Descriptive	3	
Factor analysis	2		Expert opinion&qualitative	2	
Lachenbruch classification	1		Gini's transvariation	1	
Survival analysis	1		Hill-1975 tail index	1	
Trait recognition analysis	1	23	MIMIC	1	
			Ratio analysis	1	
Signal extraction	14		Survey	1	
Signal extraction (real time)	1	15	Topological analysis	1	16
			Total		**124**

Notes Simple counts with some classification. See the Bibliography section as well as Appendix-Table A1 for details.

Data coverage of the examined studies (Table 2) support the aforementioned view that globalization was quite a strong motivation for early warning models: leaving the firm-level data on financial ratios and the like aside, data on balance of payments and fiscal performance are the first (24+129=153 out of 1005-14-382=609) followed by monetary aggregates and credit data (74+76=150 out of 609). The exchange rate and interest rate data (98 out of 609) and domestic economic activity indicators (95 out of 609) are almost equally underlined in early warning studies.

Table 2. Popularity of Variables in Early Warning Studies

Variable	Count	Subtotal	Variable	Count	Subtotal
M1,M2,M3 (excess balances)	8		Fiscal balance	24	24
M1,M2,M3 (multipliers)	11				
M1,M2,M3 (other ratios)	14		Capital account	5	
M1,M2,M3, money	15		Current account	16	
M1,M2,M3/Reserves	26	74	Exports&Imports	46	
			Debt&debt service	9	
Bank deposits	11		External debt	19	
Bid-Ask spread	4		FDI&Portfolio	8	
CB credits	8		FX reserves	26	129
Credit&credit growth	9				
Domestic credit	33		Exchange rates	11	
Household debt	1		Interest rate repricing period	4	
Loan volume volatility	5		Interest rates&differentials	15	
Loans&loan growth	5	76	Real Exchange Rates	27	
			Real Interest Rates	24	
Average maturity&duration	9		Terms of trade	17	98
Capital adequacy	5				
Non-Performing Loans	13	27	Expectations	5	
			Inflation	27	32
Capacity utilization	1				
GDP&growth&composition	44		Political&Institutional&Social&Geographical	42	42
Indicators	6				
IP&economic activity	12		Return on Assets&Return on Equity	9	
Stock market&prices	31		Value at Risk	3	
Unemployment	1	95	Working capital	2	14
World growth&performance	4		Financial ratios&other	382	382
World&DC interest rates	8	12	**Total**		**1005**

Notes Simple counts with some classification. See the Bibliography section as well as Appendix-Table A1 for details.

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The code of each study (see Appendix Table A1) is given in square brackets.

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Appendix

List of Methodologies and Variables

The studies for which I have adequate information about methodology and data coverage are listed in the table below. **Year**: publication year, **Focus**: main interest/motivation of the study, **Method**: methodology maintained in the study, **Data Coverage**: included variables/sets of variables. In order to save space, full-citation format is avoided in this table. **Code** can be used to link the table below to the Bibliography section.

Table A1. List of Methodologies and Variables

Code	Year	Focus	Method	Data Coverage
0106	2011	Monitoring	Diffusion index	Miscellaneous (132 Monthly Time Series)
0004	2010	Banking crises	Logit	Real GDP Growth, Real Interest Rate, Inflation, Fiscal Surplus/GDP, M2/Foreign Exchange Reserves, Real Domestic Credit Growth, Liquidity Ratio, Unweighted Capital Adequacy Ratio, Real Property Price Growth
0007	2009	Financial crises	Gini's transvariation	Cad/GDP, M2growth, GDP Pro Capita Growth, Government Debt (P.C. GDP), Investment/GDP(Variation), Reserves Variation, Domestic Credit/GDP, Short Term Debt (P.C. GDP), External Debt (P.C GDP), Inflation (Variation)
0006	2009	Exchange rate regimes	Hill (1975) estimator of tail index	Daily Nominal Exchange Rate
2005	2009	EWS, economic and financial risks	Indicator design	Oil Price, Us Leading Index, M2, Real Stock Price, Manufacturing Of Industrial Products, Expectations For Demand For Finished Goods, Stock Of Finished Goods, Activity Index, Real Wages, Economically Active Population, Retail Sales, Composite Financial Market Risk Indicator M2/Foreign International Reserves, Real Exchange Rate, Real Rate Of Interest, World Interest Rate Differential, Trade Deficit Ratio, Long Term Foreign Liabilities Of Banks/Foreign Assets, Bank Loans/Trade, Total Bank Loans Growth, Interest Rate Companies Paying To Banks – Inflation, Profitability Of Banks, Total Bank Loans/GDP, M2/Total Loans, Ifo World Economic Survey
2004	2009	EWS, 2008 crisis	MIMIC model	Overall Capital Stringency, Capital Regulatory Index, Official Supervisory Power, Ability To Take Prompt Corrective Action, Restructuring Power, Declaring Insolvency Power, Credit Market Regulation, Private Bank Ownership, Foreign Bank Competition, Interest Rate Controls/Negative Real Interest Rate, Domestic Credit Private Sector, Domestic Bank Credit, Private Sector Credit Access, Bank Non-Performing Loans, Bank Liquid Reserves, Bank Capital, Bank Claims, Asset Price Appreciation, Stock Market Growth, Market Cap, Stocks Traded, International Imbalances, Net External Position, Current Account, Debt Service, External Debt, Gross Financing Via International, Capital Markets, Real Effective Exchange Rate 2006 (2000=100), Total Reserves/External Debt, Short-Term Debt/Reserves, Total Reserves, Import Months, M2/(Total Reserves – Gold), M2, Central Bank Foreign Assets, Currency Union Member Dummy, GDP Of Monetary Zone, Inflation Targeter Dummy, M2/GDP, M3/GDP, Gov't Budget Surplus/Deficit/GDP, Central Gov't Debt/GDP, Debt/GNP, Debt Service/GDP, CPI Inflation, GDP Growth, Institutions, Regulation, Polity, Constraints On Executive, Overall Economic Freedom, Common Law Country, Control Of Corruption, Regulatory Quality Rule Of Law, Political Rights, Civil Liberties, Government Size, Legal Security Of Property Rights, Sound Money Access, Geography Log Of Latitude Commodity Exporter, Language
2006	2009	Asset price boom-bust cycles, real time	Real-time signal extraction	Real GDP, Private Final Consumption Expenditure, Gross Total Fixed Capital Formation, Private Residential Fixed Capital Formation, Real Aggregate Asset Price Index, Real Equity Price Index, Real Residential Property Price Index, Long-Term Bond Yield, Nominal, Long-Term Real Bond Yield, Short-Term Nominal Interest Rate, Short-Term Real Interest Rate, Long-Term Bond Yield Minus Short-Term Interest Rate, Real Effective Exchange Rate Index, M1, M3, Real Private Credit, Real Domestic Credit, Respective Ratios Of Nominal Variables
0009	2008	Currency crises	Diffusion index	M2 Multiplier, Domestic Credit/GDP, Real Interest Rate, Lending–Deposit Rate Ratio,M2/Reserves, Bank Deposits, Exports, Imports, Terms Of Trade, Stock Returns, Output
0013	2008	Banking crises	Multivariate logit, signal extraction	Real GDP Growth, Change in Terms Of Trade, Depreciation, Real Interest Rate, Inflation, Real GDP Per Capita, Fiscal Balance/GDP, M2/İnternational Reserves, Private Credit/GDP, Deposit Insurance, Credit Growth
0012	2008	Currency crises	Probit	Exchange Rate, Foreign Currency Reserves, Interest Rates, Currency Base, M2, Consumer Price Index, Domestic Credit, PIB
2013	2007	Interbank payment flows, topology	Topological analysis, Clustering	Bank Transactions Data

0015	2006	Insurance	Multivariate discriminant analysis (MDA), Logistic regression, Two artificial neural network models	Gains/Premiums, Liabilities/Surplus, Net Gain From Operations After Tax and Dividends, Net Investment Income, Accident and Health Benefits/Total Benefits, (Bonds+Stocks+Mortgages)/Cash and Investment Assets, Cash Flow/Liabilities, Capital and Surplus/Liabilities, Change in Capital and Surplus, Delinquent Mortgages/Capital and Surplus, Change in Premium, Insurance Leverage (Reserves/Surplus), Financial Leverage (Premiums/Surplus), Log Of Growth in Assets, Log Of Growth in Premiums, Log Of Growth in Surplus, Log Of Cash Flow From Operations, Nonadmitted Assets/Admitted Assets, Reinsurance Ceded/Premium, Separate Account Assets/Assets, Total Benefits Paid/Capital and Surplus, Real Estate/Assets
0016	2006	Financial crises	Value-at-Risk	VaR/Net Reserves, VaR/P, P-VaR, Sa Composite Index, Sa Composite Index, Exports, Imports, Terms Of Trade, Real Exchange Rate, Debt/GDP, Interest Rate Differential, M1/Net Reserves, Net Reserves, GDP Growth, Industrial Output Index, Stock Market Index), M1/Monetary Base
3030	2005	Economic activity, leading indicators	Composite leading indicator	Capacity Utilization Rates, Production Amounts Of Selected Industrial Goods, Wholesale Price Index (WPI), Imports, Consolidated Budget Items, Expectations Related With Supply Side, Consumer Price Index (CPI), Exports, Sales Of Selected Industrial Goods, Cost Of Living Indices For Wage Earners, Construction Statistics, Consolidated Budget Items, Expectations Related With Demand Side, Monetary Aggregates, Exchange Rates, Real Exchange Rates, Interest Rates
0019	2005	Bank failures	Logit	Capital/Total Assets, Gross Capital/Risk Assets, Total Loans/Total Capital, Loan Loss Reserves/Gross Loans, Provision For Loan Loss/Net Loans, Non-Performing Loans/Gross Loans, Loans To Insiders/Net Loans, Loans + Leases/Total Sources Of Funds, Net Income/Total Assets (Return On Assets), Return On Equity, Net Interest Margin, Loan Revenue/Total Operating Income, Liquid Assets/Total Assets, Total Loans/Total Deposits, Net Loans/Total Assets, Liquid Assets/Total Sources Of Funds, Total Op. Expenses/Operating Revenue, Loan Revenue/Net Loans, %Change in Loans/GDP, Accounts Qualification Going Concern, Local/Foreign Ownership Dummy, Real GDP Growth
0020	2005	Asian crises, Markov-switching	Markov-switching	Public Deficit, Central Bank's Credit To The Public Sector, Production Growth, Inflation, Stock Prices, Banking Fragility, Trade Balance Deficit, Overvaluation Of The Real Exchange Rate, Vulnerability To Capital Outflows, Growth Of Official External Reserves, A Proxy For Contagion In The Same Region, 3-Months LIBOR Interest Rate
0107	2005	Country risk, spillover effects	VARMA-GARCH	ICRG Data On Economic, Financial, Political and Composite Risk
0025	2004	Banking, Islamic banks	Discriminant analysis	Total Income/Total Assets, Investment Income/Total Income, Total Income/General and Administrative Expenses, Provisions For Bad Debts and Investments/Total Assets, Cash/Total Deposits, Customers Investment Deposits/Shareholders Equity, Net Profit Before Zakat and/Or Taxes/Total Assets
0023	2004	Financial crises	Exchange market pressure index (EMPI) + signal extraction with threshold	Real Exchange Rate, Exports, M2/İnternational Reserves, Real Output, Excess Real M1 Balances, International Reserves, M2 Multiplier, Domestic Credit/Nominal GDP, Terms Of Trade, Real Interest Rate On Deposits, Imports, Domestic/Foreign Real Interest Rate Differential, Ratio Of Lending Interest Rate To Deposit Interest Rate, Bank Deposits
3003	2003	EWS, financial crises	"Damocles"	Foreign Reserves/Imports, Foreign Reserves/Short-Term External Debt, External Debt As % Of GDP, Short-Term External Debt As % Of Exports, Current Account As % Of GDP, Broad Money/Foreign Reserves, Domestic Private Credit As % Of GDP, Real Short-Term Interest Rate, Stock Market Index, Real Trade-Weighted Exchange Rate
2018	2003	EWS	Descriptive	Miscellaneous Socio-Economic Indicators
3005	2003	Common vulnerabilities	Exchange market pressure index (ISP) + signal extraction, Dynamic factor analysis	Nominal Us Dollar Exchange Rate, Level Of Foreign Exchange Reserves, Nominal GDP, M2, Consumer Price Index, Stock Market Index, Short-Term Interest Rate, Total Foreign Liabilities Outstanding, Domestic Credit Outstanding, Us High-Yield Interest Rate Spread
0028	2003	Indicators	Factor analysis, Logit	Real Exchange Rates, Export Growth, Import Growth, Terms Of Trade, Current Account/GDP, M2/Foreign Exchange Reserves, Growth Of Foreign Exchange Reserves, M1 and M2 Growth, M2 Money Multiplier, Domestic Credit/GDP, Excess Real M1 Balances, Domestic Real Interest Rate, Lending and Deposit Rate Spread, Commercial Bank Deposits, Ratio Of Bank Reserves To Bank Assets, Ratio Of Fiscal Balance To GDP, Ratio Of Public Debt To GDP, Growth Of Industrial Production, Changes in Stock Prices, Inflation Rate, GDP Per Capita, Growth Of National Saving, Growth Of World Oil Prices, Us Interest Rate, OECD GDP Growth
0027	2003	Monetary policy	Macroeconomic conditions index	Current Account Balance/GDP, Rate Of Inflation, Real Rate Of Interest, Real GDP Growth Rate, Capital Flows/GDP, Change in Exchange Rate, Fiscal Deficit/GDP, Foreign Exchange Reserves/Broad Money, Domestic Credit/GDP, Broad Money/Narrow Money
3002	2003	Financial soundness, market volatility	Market volatility indicator	Foreign Exchange Indicators, Stock Market Indicators

3007	2003	EWS, regime-switching approach	Markov-switching	Deviation Of RER From Trend, Ca/GDP, Export Growth Rate, M2/Reserves Level, M2/Reserves Growth Rate, Reserves Growth Rate, Growth Rate Of Real Domestic Credit Deflated By Nominal GDP, Growth Rate Of IP, Real GDP Growth Rate, Stock Market Performance, RIR, LIBOR, Bank Assets/GDP, Short-Term Debt To Reserves, Cumulative Non-FDI Flows/GDP, Portfolio Flows Share in Total Capital Flows, Bank Reserves/Total Bank Assets, CB Credit To Banks/Total Bank Liabilities, Bank Deposits/M2 Level, Bank Deposits/M2 Growth Rate, Loans/Deposits Level, Loans/Deposits Growth Rate
3004	2003	Contagion, distance as a measure	Panel regression	Stock Market Indices, Real Exchange Rates, Distance Between The Two Cities Of Stock Markets, Variance Of Stock Returns, Short-Term Interest Rates, Consumer Price Index, Gross Domestic Product, Exports, Imports, Reserves, Exchange Rates Expressed As US$/NCU, Common Border Dummy, Common Official Language Dummy
3006	2003	Financial soundness, indicators	Survey	Average Bid-Ask Spread in The T-Bill Or CB-Bill Market, Ratio Of CB Credit To Depository Corporations To Depository Corporations' Total Liabilities, Ratio Of Consumer Deposits To Total Noninterbank Loans, Ratio Of Customer Foreign Currency Deposits To Total Noninterbank Foreign Currency Loans, Ratio Of Foreign Currency Assets To Own Funds, Ratio Of Net Foreign Currency Position To Own Funds, Average Interest Rate Repricing Period For Assets, Average Interest Rate Repricing Period For Liabilities, Duration Of Assets, Duration Of Liabilities, Ratio Of Gross Equity Position To Own Funds, Ratio Of Net Equity Position To Own Funds, Ratio Of Gross Position in Commodities in Own Funds, Ratio Of Net Position in Commodities To Own Funds, Average Interbank Bid-Ask Spread For 3-Month Local Currency Deposits, Ratio Of Liquid Assets To Total Assets, Ratio Of Liquid Assets To Liquid Liabilities, Average Maturity Of Assets, Average Maturity Of Liabilities, Average Daily Turnover in The T-Bill Or CB-Bill Market, Average Bid-Ask Spread in The T-Bill Or CB-Bill Market, Ratio Of CB Credit To Depository Corporations To Depository Corporations' Total Liabilities, Ratio Of Consumer Deposits To Total Noninterbank Loans, Ratio Of Customer Foreign Currency Deposits To Total Noninterbank Foreign Currency Loans, Ratio Of Foreign Currency Assets To Own Funds, Ratio Of Net Foreign Currency Position To Own Funds, Average Interest Rate Repricing Period For Assets, Average Interest Rate Repricing Period For Liabilities, Duration Of Assets, Duration Of Liabilities, Ratio Of Gross Equity Position To Own Funds, Ratio Of Net Equity Position To Own Funds, Ratio Of Gross Position in Commodities in Own Funds, Ratio Of Net Position in Commodities To Own Funds Ratio Of Liquid Assets To Total Assets, Ratio Of Liquid Assets To Liquid Liabilities, Average Maturity Of Assets, Average Maturity Of Liabilities, Average Daily Turnover in The T-Bill Or CB-Bill Market, Car, Basel Tier 1 Capital To Risk-Weighted Assets, Distribution Of Cars, Leverage Ratio, Distribution Of On-Balance Sheet Assets By Basel Risk-Weighted Category, Ratio Of Total Gross Asset Position in Financial Derivatives To Profits, Ratio Of Total Gross Liability Position in Financial Derivatives To Own Funds, Distribution Of Loans By Sector For Investment In Commercial Real Estate Or For Investment in Residential Real Estate, Distribution Of Credit Extended By Sector, Distribution Of Credit Extended By Country Or Region, Ratio Of Credit To Related Entities To Total Credit, Ratio Of Total Large Loans To Own Funds, Ratio Of NPL To Total Assets, Ratio Of NPL Net Of Provisions To Total Assets, Ratio Of Corporate Debt To Own Funds, Ratio Of Corporate Profits To Equity, Ratio Of Corporate Debt Service Costs To Total Corporate Income, Corporate Net Foreign Currency Exposure, Ratio Of Household Total Debt To GDP: Mortgage Debt To GDP, Debt Owed To Depository Corporations To GDP, Number Of Applications For Protection From Creditors, Rate Of Change in Number Of Depository Corporations, ROA, ROE, Ratio Of Net Interest Income To Profits, Ratio Of Trading and FX Gains/Losses To Profits, Ratio Of Operating Costs To Net Interest Income, Ratio Of Staff Costs To Operating Costs, Spread Between Reference Lending and Deposit Rates, Share Of Assets Of The Three Largest Depository Corporations in Total Assets Of Depository Corporations, Distribution Of 3-Month Local Currency Interbank Rates For Different Depository Corporations
3010	2002	Leading indicators, growth, inflation	ARMA, Intervention function, Combination of forecasts	A Wide Set Of Indicators
0031	2002	Financial crises	Binomial logit	REER Overvaluation, Current Account/GDP, Trade Balance/GDP, Terms Of Trade, Export and Import Growth, Short-Term Debt/Reserves, Total Debt/Reserves, Debt Composition, FDI, Portfolio Investment, Total Net Capital Inflows, Foreign Exchange Reserves (Level and Growth Rate), Real GDP Growth Rate, Fiscal Stance, Public Debt (P.C. GDP), Inflation Rate, Domestic Investment Ratios, Real Estate Sector, Dom. Credit To Private and Gov. Sector (Level and Gr. Rate), Deposit/Lending İ.R. Spreads, M1,M2 (% GDP, and Res)., Equity Market Indices, Bank Deposits, GDP Growth Rate in G3, Us, EU Interest Rates, Equity Market Performance in G3, Commodity/Oil Price, Trade Channel, Financial Interdependence

0034	2002	Bank fragility	CAMEL: Capital adequacy, Asset quality, Management quality, Earnings and Liquidity	Accounting Data Of Banks, Implicit Cost Of Deposit Insurance Of An Individual Bank, Credit Rating Of The Bank. Balance Sheet and Income Statement Data, Daily Market Values Of The Equity Of Banks, Credit Ratings Of Financial Institutions, Default Frequencies, Foreign Ownership Data, Connectedness, Type Of Financial Institution
3015	2002	Currency crises, Markov chains	Markov-switching	Real Exchange Rate, Domestic Credit, M2/Reserves, Domestic Credit
2019	2002	EWS, financial distress	Signal extraction	Exports, Imports, Trade Balance, Net International Reserves (NIR), M2/NIR, Interest Rate Differential, Real Exchange Rate (RER), Domestic Credit/GDP, Stock Price Index
0032	2002	Default, currency crises, ratings	Signal extraction	Moody's Investors Service and Standard and Poor's Ratings
0033	2002	Financial crises, Asia	Signal extraction	Real Exchange Rates, Trade Balance/GDP, Current Account Balance/GDI Ratio, Export Growth, Ratio Of Foreign Liabilities To Foreign Assets Of The Banking Sector, Deviation From Its Trend, Ratio Of M2 To Foreign Reserves, Ratio Of Short-Term Debt To Foreign Reserves, Growth Of Foreign Reserves, M2 Money Multiplier, Ratio Of Domestic Credit To GDP, Ratio Of The Real M1 Balance To İts Trend, Ratio Of Central Bank Credit To The Public Sector To GDP, Growth Of İndustrial Production, Real Us Exchange Rate
0036	2001	Bank failures	Bayesian belief revision (Naïve Bayes, Composite Attributes, Induced Decision Tree)	Asset Quality, Overhead Risk, Earnings Risk, Net Charge-Offs To Gross Loans, Nonperforming Loans To Total Assets, Nonperforming Assets To Total Assets, Past Due Loans To Gross Loans, ROE, ROA
0038	2000	Banking sector	Descriptive	A Wide Set Of Macroeconomic, Stock Market and Sector-Specific İndicators
0037	2000	Currency crashes	Four types of threshold filters: ordinary, multilinear, union and intersection	Gross İnternational Reserves, Government Balance, Growth in Domestic Credit, Four-Year Growth Of RER, Foreign Direct İnvestment, Portfolio İnvestment, Debt Service Relative To Exports, External Debt Relative To Exports, Share Of Official Debt in Total Debt, Real GDP Growth, IP Growth
0040	2000	Bank supervision	Logit, Trait Recognition Analysis (TRA)	Net İncome After Taxes/Total Assets, Non-İnterest Expenses/Total Assets, Number Of Bankruptcy Filings, Business Bankruptcy Filings İnformation, Number Of On-Business Bankruptcy Filings, Dummy For De Novo Bank (Measured By Age Less Than 10 Years), Dummy For Metropolitan Statistical Area Versus Rural Location Of The Main Office, Total Assets, Age Of The Bank Based On The Establishment Date, Average Quarterly Loan Growth Over The Year For Agricultural Loans/Total Loans, Average Quarterly Loan Growth Over The Year For Commercial and İndustrial Loans/Total Loans, Average Quarterly Loan Growth Over The Year For Commercial Real Estate/Total Loans, Average Quarterly Loan Growth Over The Year For Consumer Loans/Total Loans, Average Quarterly Loan Growth Over The Year For Mortgage Loans/Total Loans, Provisions For Loan and Lease Losses/Total Assets, Other Borrowed Funds/Total Assets, Core Deposits/Total Deposits, Total Cash Dividends/Total Assets, Net İnterest İncome Plus Non-İnterest İncome/Non-İnterest Expenses, Number Of Full-Time Employees/Total Assets, Short-Term İnterest Rate Gap/Total Assets, Income Per Capita, Loans Made To İnsider/Total Assets, Insured Deposits/Total Liabilities, Jumbo Cds/Total Assets, Short-Term Assets/Short-Term Liabilities, Total Loans/Core Deposits, Total Loans/Total Deposits, Average Maturity Of Assets (Years), Non-Performing Loans Past Due More Than 90 Days and Still Accruing/Total Assets, Non-Performing Loans Past Due More Than 90 Days and Not Accruing/Total Assets, Agricultural Non-Performing Loans/Total Agricultural Loans, Commercial and İndustrial (CandI) Non-Performing Loans/Total Commercial and İndustrial Loans, Consumer Non-Performing Loans/Total Consumer Loans, Real Estate Non-Performing Loans/Total Loans Secured By Real Estate, Foreign Exchange Transactions/Total Assets, Off-Balance Sheet İnterest Rate Risk/Total Assets, Off-Balance Sheet Loan Commitments/Total Assets, Other Real Estate Loans/Total Assets, Number Of Permits Per Capita, Provision To Loan and Lease Losses/Ta, Investment Securities/Total Assets, Volatility Of Agricultural Loan Volume, Volatility Of Commercial and İndustrial (CandI) Loan Volume, Volatility Of Commercial Real Estate Loan Volume, Volatility Of Consumer Loan Volume, Volatility Of Residential Mortgage Loan Volume, Net İncome/Non-İnterest Expenses
3021	2000	Vulnerabilities, measurement	Qualitative comparisons, Econometric modeling, Non-parametric estimation	GDP, Output Gap, Budget Balance, Equity Prices, International Reserves, Real Exchange Rate, Current Account, Exports, External Debt, Credit, Real İnterest Rate, Debt To İnternational Banks, Inflation, Capital Account, Money Supply, Terms Of Trade, Contagion, Political/Legal
0045	1999	Insurance, insolvency	Logit	Premium-To-Surplus (Net Premiums Written/Surplus), Liability Ratio (Total Liabilities/Cash and Invested Assets), Loss Ratio (Losses Incurred and Loss Expenses/Premium Earned)

0041	1999	Banking, balance of payments	Signal extraction	M2 Multiplier, Domestic Credit/GDP, Real İnterest Rate, Lending-Deposit Rate Ratio, Excess M1 Balances, M2/Reserves, Bank Deposits, Current Account, Exports, Terms Of Trade, Real Exchange Rate, Imports, Capital Account, Reserves, Real İnterest-Rate Differential, Output, Stock Prices
0044	1999	Currency crises, banking crises	Signal extraction, Composite indicators	M2 Multiplier, Domestic Credit/GDP, Domestic and External Liberalization, Bank Deposits, Excess M1 Balances, Exports, Imports, Terms Of Trade, Real Exchange Rate, Reserves, M2/Reserves, RIR Differential, World RIR, Foreign Debt, Capital Flight, S/T Foreign Debt, Output, Domestic RIR, Lending/Deposit Rate Ratio, Stock Prices
0046	1999	Currency crises	Signal extraction, Probit, Cross-country regressions	RER, M2/Reserves Growth Rate, Export Growth Rate, International Reserves Growth Rate, Excess M1 Balances, Domestic Credit/GDP Growth Rate, RIR, M2 Multiplier Growth Rate, Import Growth Rate, İndustrial Production Growth Rate, Tot Growth Rate, Lending Rate/Deposit Rate, Bank Deposit Growth Rate, Stock Price Index Growth Rate, Real İnterest Differential, Ca/GDP, M2/Reserves Level
0051	1998	Financial crises	Descriptive	Real GDP Growth, Inflation, Domestic Saving, Fixed Capital Formation, General, Government Balance, Public Sector Balance, M2 Growth (End Of Year), Domestic Credit Growth (End Of Year), Foreign Liabilities Of Banks, Current Account Balance, External Debt Service
0053	1998	Banking crises	Logit	Real GDP Growth, Change İn Tot, Rate Of Change Of The NER, Nominal İnterest Rate Minus The Contemporaneous Rate Of Inflation, Rate Of Change Of The GDP Deflator, Budget Surplus/GDP, M2/Reserves, Domestic Credit To Private Sector/GDP, Bank Liquid Reserves/Assets, Real Domestic Credit Growth, Dummy For An Explicit Deposit Insurance Scheme, Real GDP Per Capita, Index Of The Quality Of Law Enforcement
0049	1998	Currency crises	Signal extraction	Banking Crisis, Real Exchange Rate, Real İnterest Rate, Imports, M2 Multiplier, Output, Bank Deposits, Excess M1 Balances, Exports, Terms Of Trade, International Reserves, Stock Prices, Real İnterest Differential, M2/İnternational Reserves, Lending Rate/Deposit Rate, Domestic Credit/GDP
0052	1998	Financial crises, balance of payments	Signal extraction	M2 Multiplier, Domestic Credit, M2/Reserves, Lending/Deposit Rate, Deposits, Real Interest Rate, Excess Money Balances, Exports, Imports, Real Exchange Rate, Reserves, Interest Rate Differential, Output Growth, Stock Market Prices
0055	1997	Banking system fragility	Logit, Survival analysis	Capital-Asset Ratio, Nonperforming Loans/Total Loans, Nonsecuritized Loans/Total Loans, Mortgage Loans/Total Loans, Consumer Loans, Agriculture-Related Loans/Total Loans, Profit Margin, Public Deposits/Total Loans, Interbank Loans/Total Loans, Expenditures/Total Assets, Liquid Assets/Total Assets, Bank Assets/Total Banking Sector Assets, Total Banking Sector Loans/GDP, Banking Sector Risky Loans, Banking Sector Fragility, Deposit Fund Fobaproa, Exchange Rate Depreciation, Real İnterest Rate, Economic Activity, Unexpected Inflation
3027	1996	Inflation, Markov-switching	Markov-switching	Inflation
0057	1995	Speculative attacks	Index of speculative pressure	Total Non-Gold İnternational Reserves; Period-Average Exchange Rates; Short-Term İnterest Rates, Exports and Imports; Current Account (Converted To Domestic Currency), Central Government Budget Position As Percentage Of Nominal GDP; Long-Term Government Bond Yields; Stock Market Index; Domestic Credit; M1; M2; CPI; Real GDP, Real Effective Exchange Rate, Employment, Unemployment Rate, Business Sector Wage Rate
0058	1994	Insurance, insolvency	Neural networks	Policyholders' Surplus, Potentially Impaired Surplus, Capitalization Ratio, Excessive Unrealized Capital Gains and Losses To Surplus, Negative Cash Flow, Net Change İn Cash and Short-Term Investments, Reinsurance Recoverable/Policyholders' Surplus, Change İn Invested Assets, Significant Change İn Short-Term Investments, Aggregate Write-In Assets, Investment Yield Based On Average Invested Assets, Ratio Of Significant Receivables From Parent, Subsidiaries, and Affiliates To Capital and Surplus, Noninvested Assets, Current Year Net Underwriting Loss, Premium To Surplus, Surplus Aid To Surplus, Two-Year Overall Operating Ratio, Investment Yield, Change İn Surplus, Liabilities To Liquid Assets, Agent's Balance To Surplus, Two-Year Reserve Development To Surplus, Potential Impaired Surplus/Policyholders' Surplus
0061	1992	Insurance, financial distress	NPDM, Logit, Probit, Lomit, Burrit	Net İncome/Total Assets, Surplus (Equity), Net İncome/Surplus, Inverse Coefficient Of Variation Of Operating Ratios, Liability Decomposition Measures

0062	1990	Sovereign debt ratings	Analytical hierarchy process	Type Of Government, Process and Frequency Of Political Succession, Degree Of Public Participation, Degree Of Centralization İn Decision making Processes, Executive Leadership, Relationship With Supporting Government, Relationship With Supporting Political Coalitions, Government Institutions, Responsiveness and Access To Executive Leadership, Effectiveness and Efficiency, Policy Responsibilities, Social Coalitions, Major Socio-Economic and Cultural Groups, Political Parties and Their Constituencies, Level and Growth Of Per Capita Income, Distribution Of Wealth and Income Regional Disparities, Homogeneity Of The Populace, External Relations, Relationship With Major Trading Partners, Relationship With Neighboring Countries, Participation İn International Organizations, Economic Risk, Demographic Characteristics, Level and Growth Of Population, Age Distribution, Urbanization Trends, Extent and Quality Of Infrastructure, Natural Resource Endowment, Distribution Of Productive Activities, Public Sector Participation İn Productivity Activities, Recent Economic Trends: Composition and Growth Of Aggregate Demand, Domestic Economy, External Sector, Economic Policy, Price Wage Policies, Monetary Policy, Fiscal Policy, External Policies, Long-Term Planning
0063	1989	Qualitative forecasting	ARIMA model, expert as the conditioning vector	Hog Prices
0064	1989	Debt rescheduling	Forecast combination	Rescheduling Data, Subjective Country Risk Ratings
0065	1988	Bank condition, financial data	CAMEL, Logit	Primary Capital/Average Assets, Payout Ratio, Asset Growth Rate, Net Loan and Lease Charge-Off, Loans and Leases, Current Recoveries/Prior Charge-Offs, Nonperforming Loans and Leases/Primary Capital, Loans and Leases, Past-Due and Nonaccrual/Gross Loans and Leases, Loan Loss Reserve/Total Loans and Leases, Return On Average Assets, Adjusted Return On Average Assets, Pretax Return On Average Assets, Net İnterest Margin, Overhead Expense/Average Earning Assets, Provision For Loan Losses/Average Earning Assets, Securities Gains Or Losses/Average Earning Assets, One Year Gap/Equity Capital, One Year Gap/Total Assets, Average Earning Assets/İnterest Bearing Liabilities, Loans Plus Securities/Total Sources Of Funds, Volatile Liabilities/Total Sources Of Funds, Net Funds Dependency, Brokered Deposits/Total Deposits
0067	1986	Debt rescheduling	Logit, Discriminant model	Exports/Imports, Reserves/Imports, Total Debt/Exports, Short-Term Debt/Imports, Amortization Rate, Current Debt Service Ratio, Interest Rate Sensitivity Indicator, Bank Lending, Real GDP Growth Rate
0066	1986	Solvency	Regression	The Premium-To-Surplus Ratio, Net Premiums Written, Net Premiums Written For All Insurance Coverages, Net Premiums Written For Miscellaneous Liability Insurance and Workers' Compensation Insurance, Market Value Of Common Stocks Divided By Admitted Assets, Total Property-Liability Net Premiums Written For The İnsurer's Affiliated Group, Total Property-Liability Net Premiums Written Plus Life and Health Insurance Premiums For The İnsurer's Affiliated Group, Dummy İf The İnsurer's Affiliated Group İs Owned By A Conglomerate, Dummy For A Mutual İnsurer, Dummy For A Direct Writer
0068	1985	Solvency	Index of solvency	Debt Stock, Exports, Real GDP Growth, Real İnterest Rates
0069	1984	Financial distress	Weighted exogenous sample maximum likelihood (WESML), conditional maximum likelihood (CML), and full information concentrated maximum likelihood (FICML)	
0070	1983	Grain elevator bankruptcy	Logit, Linear probability function (LPF)	Liquidity, Solvency, Activity, Profitability
0071	1983	Bank failures, contagion effects	Regression	Weekly Rates Of Return (Split- and Dividend-Adjusted)
0072	1982	Monitoring, mutinationals	Clustering, Discriminant analysis	Age Of Firm, Employment İn The Firm As At 1976, Projected Changes İn Employment, Index Of Functional Areas Of Management, Number Of Additional European Affiliates, Relative Position Of Establishment, Percentage Of Turnover Derived From İntragroup Sales, Executive Assessment Of The Past Importance within The European Operations, Executive Assessment Of The Importance Of Within The European Operations, Executive Assessment Of The Future Importance Within The European Operations, Performance İn Relation To That Of Other European Subsidiaries. Level Of Operating Costs relative To That Of Other European Subsidiaries, Percentage Of Times That Performance Targets Were Not Achieved

0073	1981	Debt servicing capacity	Logit	Debt Service Ratio, Foreign Exchange Reserves To Imports Ratio, Ratio Of Net Noncommercial Foreign Exchange Inflows To Debt Service Payments, Ratio Of Commercial Foreign Exchange Inflows To Debt Service Payments, Exports To GNP Ratio, Real Per Capita GNP To U.S. Per Capita GNP Ratio
0078	1980	Business failure	Discriminant analysis	Return On Assets, Earnings Before Interest and Taxes/Total Assets, Leverage Ratios, Earnings Before Interest and Taxes/Interest Coverage, Cash Flow/Total Debt, Market Value Of Equity/Total Capital, Liquidity Ratios, Current Assets/Current Liabilities, Net Sales/Cash, Receivables Net Sales/Receivables, Net Sales/Inventories, Sales Per Dollar Net Sales/(Current Assets - Current Liabilities), Retained Earnings/Total Assets, Total Assets (İn Thousands Of Dollars)
0074	1980	Bank regulation, insolvency	Fama, Fisher, Jensen, and Roll (F.F.J.R.)	Return On Bank Equity, Dates Of Bank Failure
0076	1980	On-site bank examination	Lachenbruch classification technique	Return Data
0075	1980	Bankruptcy, financial rations, probabilistic prediction	Logit	Total Assets/GNP Price-Level Index, Total Liabilities/Total Assets, Working Capital/Total Assets, Current Liabilities/Current Assets, Dummy(Total Liabilities>Total Assets), Net İncome/Total Assets, Funds Provided By Operations/Total Liabilities, Dummy(Net İncome<0 Last Two Years), Change İn Net İncome
0079	1980	Insurance, solvency	Simultaneous equation systems	Financial Ratios, İnsolvency Data
0082	1979	Repayment prospects	Precedent-based forecasting	International Reserves/Imports, Debt Service Ratio, Reserve Position İn The Imf/İmports, Exports/GDP, Disbursed Debt Outstanding/Exports, Annual Inflation Rate, Imports/Exports, Supplier Disbursed Debt Outstanding/Disbursed Debt Outstanding, İnterest Payments/Disbursed Debt Outstanding, Supplier Disbursed Debt Outstanding/Imports
0084	1977	Bank failures	Discriminant analysis	Total Operating İncome/Total Assets, Total Operating Expense/Total Assets, Net Operating İncome/Total Assets, Net İncome/Total Assets, Net İncome/Total Capital, Total Operating Expense/Total Operating İncome
0085	1977	Financial failure, forecasting	Discriminant analysis (Altman)	Working Capital/Total Assets, Retained Earnings/Total Assets, Earnings Before İnterest and Taxes/Total Assets, Market Value Of Equity/Book Value Of Total Debt, Sales/Total Assets
0086	1976	Over-the-counter broker-dealers	Discriminant analysis	Net Income/Total Assets, Total Liabilities+Subordinate Loans/Owners Equity, Total Assets/Adjusted Net Capital, Ending Capital- Capital Additions/Beginning Capital Scaled Age
0087	1975	Exchange rate movements, discriminant analysis	Discriminant analysis	Reserve Growth Ratio, Extended Money Supply Ratio, Price Index Ratio, Ratio Of Exports To Imports, Investment Service Ratio, Marginal Propensity To Import Ratio, Central Bank Discount Rate
0088	1975	Bank stability, problem banks	Multiple discriminant analysis	(Cash + U.S. Treasury Sec.)/Assets, Loans/Assets, Provision For Loan Losses/Oper. Expense, Loans/(Capital + Reserves), Operating Expense/Operating Income, Loan Revenue/Total Revenue, U.S. Treasury Securities' Revenue/Total Revenue, State and Local Obligations' Revenue/Total Revenue, Interest Paid On Deposits/Total Revenue, Other Expenses/Total Revenue
0090	1971	Bankruptcy, railroads	Discriminant analysis, ratio analysis	Liquidity, Profitability, Efficiency, Solvency and Leverage Measures
0099		Banking sector	CAAMPL method	CAPL Variables
2028		Currency crises	Exchange market pressure index (ISP) + signal extraction with threshold, Logit, Probit	Industrial Production, Stock Exchange, Inflation, Budget Balance/GDP, M2/International Reserves, Deviation Of The Real Exchange Rate From Trend, Current Account/GDP, Short-Term Foreign Debt/International Reserves, Foreign Direct İnvestments/Portfolio İnvestments, Terms Of Trade, Ca/GDP, Nominal Us İnterest Rate, Bank Loans/Bank Deposits, Bank Reserves/Bank Assets, Bank Deposits/M2, Bank Short Position, Central Bank Credit To Banks/Bank Liabilities
2031		Credit portfolio quality	Logit	M2/İnternational Foreign Reserve, M2 Money Multiplier, Return On Assets, Consumer Price Index, Real Exchange Rate, Government Expenditure İn GDP, Degree Of Openness Of The Economy, İnterest Rate Charged For Loans, İnterest Rate Granted For Nonbank Customer Deposits, Share Of Exports İn GDP
0091		Sub-prime crisis, EWS	Logit, Binary recursive tree	Real GDP Growth, Change İn Terms Of Trade, Nominal Depreciation, Real Interest Rate, Inflation, Fiscal Surplus/GDP, M2/Foreign Exchange Reserves, Credit To Private Sector/GDP, Bank Liquid Reserves/Total Bank Assets, Real Domestic Credit Growth, Institutional Variables, Real GDP Per Capita, Dummy For Deposit Insurance

0093	Commercial banking, pattern recognition	Logit, Signal extraction	Real GDP Growth, Change İn Terms Of Trade, Depreciation, Real Interest Rate, Inflation, Real GDP Per Capita, Fiscal Balance/GDP, M2/International Reserves, Private Credit/GDP, Deposit Insurance, Credit Growth, Private Credit/GDP, Dummy For Deposit Insurance
0095	Financial crises, economic crises	Markov-chain with varying switching probabilities, VAR	Index Of Manufacturing Production, Imports, Newly Established Firms, Railway Freight, Real M1 and Real M2, Real Central Bank Credits To Banking Sector, The Ratio Of Central Bank Credits To M2, Real Value Of Capital Reinvested, Total Surface Area Of Buildings İn New Building Permits, Real Value Of Government's Consolidated Budget Expenditures, Demand For Jobs
2036	Bank failure	Markov-switching	Asset Growth, Non-Performing Loans/Loans, Income Earned But Not Received/Loans, Net Interest Income/Loans, Market Risk Liquid Assets/Liabilities, Net Loans/Deposits, Securities/Assets, Institutional Regulatory Capital/Rwa
0104	Financial failure, prediction	Multiple regression, Discriminant analysis, Logit, Probit	(Paid-İn Capital + Retained Earnings)/Total Assets, Interest Revenue/Total Assets, (Paid-İn Capital + Retained Earnings)/(Deposits + Other Liabilities), Interest Revenue/Interest Expense, Net Working Capital/Total Assets, Revenues Other Than İnterest/Expenses Other Than İnterest, (Paid-İn Capital + Retained Earnings)/(Total Assets + Guarantees Extended), Total Revenues/Total Expenses, Total Loans/Total Assets, Allowance For Uncollectibles/Total Loans, Overdue Loans/Total Loans Deposits/Total Assets, Fixed Assets/Total Assets, Net İnterest İncome/Number Of Branches, Assets Denominated İn Foreign Currency/Liabilities Denominated İn Foreign Currency, Net İnterest İncome/Total Assets, Liquid Assets/Total Assets, Net İnterest İncome/Number Of Employees, Liquid Assets/(Deposits + Other Liabilities), Interest Revenue/Total Assets, Liquid Assets Denominated İn Foreign Currency/Liabilities Denominated İn Foreign Currency, Interest Expense/Total Assets, Net Period İncome/Total Assets, Interest Revenue/Interest Expense, Net Period İncome/Shareholder's Equity, Total Loans/Deposits, Net Period İncome/Paid-İn Capital
0101	Financial crises		M2 Multiplier, Ratio Of Domestic Credit To GDP, Bank Deposit, Excess M1 Balance, Exports, Imports, Terms Of Trade, Real Exchange Rate, Foreign Exchange Reserves, Ratio Of M2 To Foreign Exchange Reserves, Real İnterest Rate Differential, World Real İnterest Rate, Foreign Debt, Capital Flight, Output, Real Domestic İnterest Rate, Ratio Of Lending Rate To Rate, Stock Prices
3029	EWS, financial crises	Probit	Stock Market Index, Exchange Rate, Exports/Imports, Money Supply M1, Domestic Credit, Consumer Price Index
0100	Systemic banking crisis	Signal extraction, Probit	Base Money, M1, M1 Multiplier, M3 Multiplier, Nominal Credit Growth, Real Deposit Rate, Real Lending Rate, Nominal İnterest Rate, Spread Ratio (Plr/Deposit Rate), Spread Difference(Plr-Deposit Rate), Spread Between Bank Rate and 91-Day T-Bill Weighted Average (Of High and Low) Call Money Rate, Return On Banking Stocks, Exports, Imports, REER Overvaluation, NEER, Ratio Of Net Current Account Balance To GDP, Terms Of Trade, Foreign Exchange Reserves, Ratio Of M3 and Foreign Exchange Reserves, Short -Term Debt, Short-Term Foreign Debt As A Proportion Of Reserves, Foreign Direct Investment, FDI As A Proportion Of GDP, Real GDP Growth, Industrial Production Index, WPI, Sandp Cnx Return, Ratio Of Fiscal Deficit To GDP, London Interbank Offer Rate (1 Month), Us 3 -Month Treasury Bill Rate, International Oil Price

Notes The table may include some unavoidable and hopefully minor typos. The spreadsheet version of the table is available from the author upon request.