

Unified Financial Analysis — The Missing Link of Finance

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Unified financial analysis

The Missing Links of Finance

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& Marco Rüstmann

Unified Financial Analysis arrives at the right time, in the midst of the current financial crisis where the call for better and more efficient financial control cannot be overstated. The book argues that from a technical perspective, there is no need for more, but for better and more efficiently organized information.

The title demonstrates that it is possible with a single but well organized set of information and algorithms to derive all types of financial analysis. This reaches far beyond classical risk and return or profitability management, spanning all risk categories, all valuation techniques (local GAAP, IFRS, full mark-to-market and so on) and static, historic and dynamic analysis, just to name the most important dimensions.

The dedication of a complete section to dynamic analysis, which is based on a going concern view is unique, contrasting with the static, liquidation-based view prevalent today in banks. The commonly applied arbitrage-free paradigm, which is too narrow, is expanded to real world market models. The title starts with a brief history of the evolution of financial analysis to create the current industry structure, with the organization of many banks following a strict silo structure, and finishes with suggestions for the way forward from the current financial turmoil.

Throughout the book, the authors advocate the adoption of a 'unified financial language' that could also be the basis for a new regulatory approach. They argue that such a language is indispensable, if the next regulatory wave – which is surely to come – should not end in expensive regulatory chaos.

Unified Financial Analysis will be of value to CEOs and CFOs in banking and insurance, risk and asset and liability managers, regulators and compliance officers, or anyone with a stake in the finance industry.

'No doubt all interested in Risk Management will learn a lot from reading this book'

Paul Embrechts, Department of Mathematics and RiskLab, ETH Zurich

'This book gives the reader a comprehensive view of the generation of risk and revenue from financial contracts to institution level.'

Julien Delbet, Head of Asset & Liability Management, Retail Banking, Société Générale.

'Readers ranging from financial practitioners and risk managers to IT professionals will benefit from giving this book a serious read.'

Christopher L. Culp, Adjunct Professor of Finance, The University of Chicago Booth School of Business, and Honorarprofessor, Universität Bern, Institut für Finanzmanagement

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Overview

- 1 Historical remarks on bookkeeping and modern finance
 - Bookkeeping
 - Modern Finance
 - The situation today
- 2 Finding the elements
 - The output elements
 - The input elements
- 3 Financial events and expected cash flows
 - Derivation of analysis elements from financial events
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 - Time and calendar time
 - The role of intervals
 - Double existence of time
- 6 Classification of analysis
 - Liquidation and going-concern view

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Bookkeeping in history: Single entry systems

- Records of economic activities as transactions, debt etc. on early cuneiform clay tablets found in Mesopotamia.
- Single entry systems with the purpose to keep records of transactions.
- Focus: realized cash flows
- No real notion of assets, liability, expense and revenue
- Any investment or even a loan is registered as a strain on cash giving a negative impression of these activities.
- Impossibility to account for value (e.g. when lending money)
- No possibility to account for continuous income

Bookkeeping in history: Double entry systems

- Invented in the 13th or 14th century in Florence (probably by the Medici family and then formalized by the monk Luca Pacioli in 1494)
- Ledger with accounts for assets (including receivables and inventories), liabilities, capital, income, and expenses.
- Pacioli warned every person not to go to sleep at night until the debits equaled the credits! Thanks to Pacioli accounting became a generally accepted and known art.
- Possibility to think in investments with delayed but very profitable revenue streams
- Turned focus away from the cash register view to value and income/expense that generates net value.
- One of the essential inventions for the European take-off.

Bookkeeping today: Value and liquidity risk

- This is by and large still the status of bookkeeping today.
- The focus on value remained.
- However, evolution of the position of cash flow within the system. (liquidity and liquidity risk in banks)
- Liquidity risk is the primal risk of banking after credit risk because the liabilities have to be much higher than available cash in order to be profitable.
- Proper representation of liquidity risk should be a flow
- But instead liquidity treated like an investment account and liquidity risk approximated with liquidity ratios.
- Cash flow statement derived from the balance sheet and P&L which itself is derived from cash flow

Savings&Loans crisis (1970–1980)

- Brought market risk in form of interest rate risk into the picture
- Savings&Loans strongly regulated since 1929:
long term mortgages (up to 30 years) financed by short term deposits (about 6 month).
- 3–6–3 rule: Pay 3% for the deposits, receive 6% for the mortgages and be at 3 o'clock at the golf course.
- Breakdown: Financing the Vietnam war with the money press lead to inflation and short-term interest rate of 20%
→ Liquidity crisis for S&L
- Refinancing on money market had disastrous effect on income
→ many bankruptcies
- Reaction of the regulator:
Gap analysis required to discover interest rate mismatches.
→ Attempts to introduce the time line into bookkeeping
- But time line opposite to value

Modern Finance: The power to explain risk

- 1800BC "Weather option" in the code of Hammurabi
- 17th c. Systematic development of probability theory
- 19th c. Systematic development of statistics
- 20th c. Mathematical modeling of finance and insurances
(mostly during the last 20 ~ 30 years)
 - 1973 First paper on option pricing by Black and Scholes
Chicapo Option Exchange opened
(Trading volume: < 1000 options)
 - 1995 Volume has increased to > 1 000 000 options/day.
"Zoo" of derivatives has developed

“Weather option” in the code of Hammurabi

If anyone owe a debt for a loan, or the harvest fail, or the grain does not grow for lack of water; in that year he need not give his creditor any grain, he washes his debt-tablet in water and pays no rent for this year.

Cited according to N. Dunbar: Inventing Money.

The situation today: Two worlds

- On one hand:
Financial systems — the double-entry bookkeeping methods
 - Strength:** the entire institutions in mind
 - Weaknesses:** Cannot analyze uncertain cash flows
- On the other hand:
Valuation methods based on stochastic models.
 - Strength:** Capability to value uncertain cash flows of complicated derivatives
 - Weaknesses:** Focusses on the single financial transaction or self-financing portfolios
 - Misses the total balance
 - Does not overlook the going concern view

The situation today: Silo structure in banks

Departments in need of and/or producing financial analysis:

- Treasury
- Controlling
 - ▶ Classical controlling
 - ▶ Risk controlling
- ALM
- Trading
- Budgeting
- Bookkeeping
- Risk departments
 - ▶ Market risk
 - ▶ Credit risk
 - ▶ Operational risk

The evolution of finance is paralleled in the evolution of IT.

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The central question

- How to build a financial system with the following characteristics?
 - ▶ It spans from simple saving accounts to exotic options as structured products.
 - ▶ An external shock like an interest rate change could be applied and then be observed moving through all financial exotic instruments and saving accounts to produce finally one consistent aggregate result on the top level
- What are the underlying ingredients or “seeds” or elements of such a system?
- How the structures could be simplified to the maximum without compromising with the results?

Output elements: Analysis of interest

Which kind of analysis is of interest?

- Liquidity
- Value and income
- Risk and sensitivity analysis

Output elements: Liquidity

- Money and financial instruments form the **counter flow** to the **flow of goods**.
- In contrast to the heterogeneous goods money or finance streams are by nature **homogeneous**
- Money, or cash flow, the only “visible”, “touchable” or “tangible” artifact of finance.

Cash, or *liquidity*, is therefore the first analysis element.

Output elements: Value and income

Two new concepts added by double-entry bookkeeping to the simple cash statement:

- **Value**
- **Income** = change of value per unit time

Output elements: Value

- Initially, value meant **nominal value**, i.e., the sum of the outstanding principal cash flows
- (Traded) stocks and bonds require a more sophisticated measure as **mark-to-market** valuation.
- Bookkeeping of traded instruments also required **more frequent re-evaluation**.
- In addition, modern financial bookkeeping as defined by IFRS 32/39 allows
 - ▶ **Amortized cost**
 - ▶ **Historical cost**

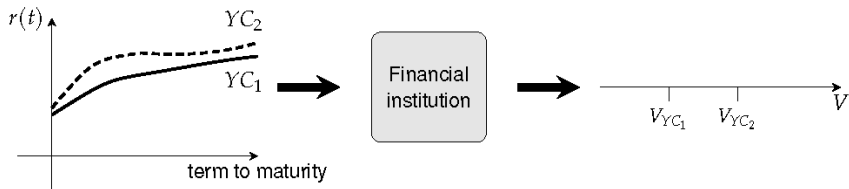
Therefore, there is the **need for parallel valuation**.

Output elements: Risk and sensitivity analysis

- Cash, value, and income only booked with the orientation towards the past.
- Is like driving a car using the rear-view mirror only:
Telling us about the past but unable to provide any indication and warning about the future.
- Since the Savings and Loans crisis and the invention of financial options, the need for more **forward looking** and more **efficient analytical methods** became apparent.
- **Forecasting** value and income under **given market conditions** was highly desirable.
- The newly introduced financial instruments such as options and futures were regarded at the time as financial time-bombs which demanded better analysis.
- → **Sensitivity analysis** and **risk management**.

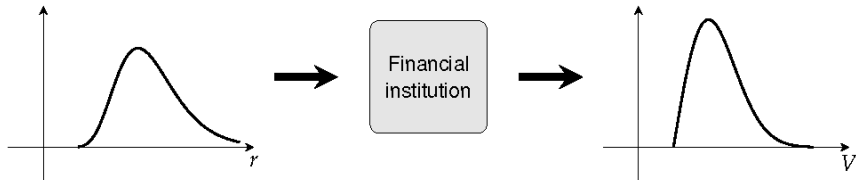
Output elements: Sensitivity analysis

- Attempts to answer quantitatively questions concerning future outcomes.
- Example:
By how much is the value of a portfolio or an entire financial institution is going to change if market interest rates change in a specific manner.



Output elements: Risk

- Replace the single risk factor shock by a distribution of changes in this risk factor
- Result is a distribution of values (instead of single shocked one).
- Sensitivity plays the same role in both cases.
- Risk analysis introduces the additional notion of distributions



Deriving the input elements

- **Question:**

What are the inputs required to calculate the output elements?

- Input elements derived from activities of financial institutions:

- ① Financial institutions are **producing financial contracts**
→ **set of rules** determining the **generation of a cash flow stream** between the counterparties.
- ② Often **contingency feature**
(e.g. variable rate instruments or options)
→ Market conditions or more generally **risk factors** required.
- ③ Contracts cannot always be fulfilled.
→ **Counter party** or **credit risk** required.
- ④ In addition, **statistical rules** which cannot be expressed on the level of a single contract.

Deriving the input elements II

These considerations lead us to identify the following input elements:

- ① Financial contracts
- ② Risk factors
- ③ Counterparties
- ④ Behavioral elements

Input element: Financial contracts

Generally speaking, **financial contracts** represent **contractually binding agreements between two counterparties that govern the exchange of cash flows** (time and amount).

Input element: Risk factors

- Financial contracts may contain clauses with **reference to market conditions**.
- **Examples:**
 - ▶ Variable rate bond or loan defines when a contract has to reprice and to which index.
 - ▶ Option pay-off depend on market conditions at maturity.
- Two **sub-groups of risk:**
 - ▶ **Market risk:**
Interest and exchange rates, stock and commodity prices.
 - ▶ **Insurance risk:**
Frequency and severity of claims, mortality rates.

Input element: Counterparties

- Whether the promises made in a contract can be kept depends on the standing or **rating** of the **counterparties**.
- Counterparties can hold **several contracts** which may or may not be **collateralized** or **guaranteed**.
- Counterparties can be **linked** among themselves by **child–parent relationships**.

All this affects the **expected loss** on any given exposure.

Input element: Behavioral elements

- **Statistical rules** cannot be encoded in contracts.
- **Examples:**
 - ▶ Contracts with **undefined cash flow profile** as saving accounts.
Cash flow pattern can only be handled statistically with replication techniques.
 - ▶ **Mortgages with prepayment.**
Problem: Option typically not exercised in rational manner.
Some debtors prepay under unfavorable conditions or do not pay where it would have been to their advantage.
→ Statistical modeling is required.
 - ▶ In **life insurance** contracts, **bonus** depending on the investment returns of the insurance company.

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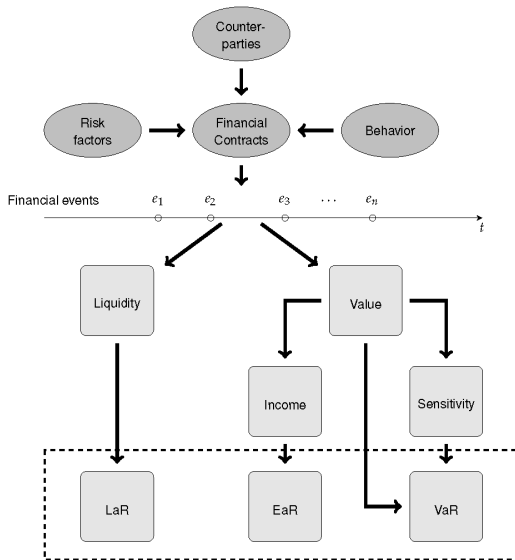
Outline of the general procedure

Starting point:

Four input elements contracts, risk factors, counterparties and behavior

- Generation of financial events representing the terms of the contract on the time line
- Generation of expected cash flows from the financial events
- Performing all desired analysis (value, income etc.) on expected cash flow streams

Financial events and expected cash flows



Financial events: Examples

Example 1: 4 year fixed rate bond with semi-annual interest payments:

- Principal payment at value date and the opposite payment date at maturity date plus eight interest payments every six months.

Example 2: Bond not fixed but reprices after two years

- Additional event — rate reset — after two years.
 - Recalculates the expected rate which in turn defines the the interest payments five through eight.

Financial events: Examples II

Example 3: Forward rate agreement (FRA) agreed in April to give or take a six months 6% loan for one million Euro starting on August 1st.

→ **Events:**

August 1st: Principal payments

February 1st:

- ▶ Payback of principal
- ▶ Interest payment of 30000 Euro

Only “notional” or virtual cash flows generated as events. **No real cash flow** occurs.

→ **Cash flows:**

Only at cash settlement date (a few days before August 1st), a net cash flow occurs which is derived from the notional cash flows.

Financial events and cash flows: Generalizations

- Value and liquidity may follow two distinct notions of cash flow.
- In fixed rate bond example they are the same.
- In FRA example:
 - ▶ Cash flows relevant for valuation are the ones from the underlying loan.
 - ▶ The liquidity cash flow is the expected cash flow at settlement date.
- In general:
 - ▶ Liquidity oriented analysis represented by settlement date cash flow.
 - ▶ Value or sensitivity oriented analysis represented by cash flows of the underlying.

Liquidity from events

- Gap and similar analysis use directly the sequence of expected physical cash flows $E_L[CF]$.
- For fixed bond: Obvious
- For FRA:
Cash flow at settlement date depend on the underlying notional cash flows and a market expectation.

Value from events

- Value of a financial transaction depends on valuation method.
- Important classes: time and market dependent methods.
 - ▶ Time dependent (essentially nominal and amortized cost):
Value calculated directly from the expected liquidity principal cash flows $E_L[CF]$.
 - ▶ Market dependent methods (mark to market):
 - ★ Meaning of *expected* cash flows must be defined precisely
 - ★ Example european options:
Expected payoff must be calculated with respect to the forward *risk-neutral* probability measure.
 - ★ In general:
Cash flow means something different for liquidity than for value and all its derived concepts.

Sensitivity from events

- First derivation of value with respect to changes in risk factor prices.
- Definition of sensitivity as the derivative applies only to market or fair valuation methods.
- Same notion of cash flow as for value applies here.
- Other methods such as the minimum value principle or lower of cost or market methods are not analytical in risk factors or are independent of them.

Risk from events

Caused by volatility of the input elements
(risk factors and behavior elements including credit risk).

The fluctuation in market prices affect liquidity, value and income:

Liquidity at risk: Liquidity is a time sequence of cash flows which cannot be reduced to a single numerical measure similar to VaR.

→ Large set of risk factor scenarios must be simulated and the corresponding expected liquidity cash flows generated on the time line

→ Define measures of liquidity risk from the result, such as the variance in a given future period.

Risk from events II

Earnings at risk: Income is like liquidity a flow concept.

→ Income or earnings at risk (EaR) requires simulation of expected income under various market and behavioral conditions.

Value at risk: Implies the use of market based valuation methods.

Sensitivity can in principle be calculated.

Common risk measures can be calculated by parametric or simulation approaches.

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The role of risk in financial analysis

Risk factors play three distinct roles in financial analysis:

- ① Drivers for the calculation of expected cash flows (e.g. IR or FX)
- ② Determine the values within the lifetime of the contracts via discounting functions.
- ③ Random variables introducing variance into the financial system.

Therefore:

For consistent modeling a well-structured simulation methodology is needed.

Taxonomy of risk categories

Parsimonious taxonomy with the following main risk categories:

Market risk: Interest rates, FX rates, stock or equity and commodity prices.

Credit risk: Changing credit worthiness of counterparties and the potential loss in case of default.

Insurance risk: Insurance risk factors as

- mortality tables in the life insurance industry.
- frequency and severity of loss claims in the non-life insurance industry.

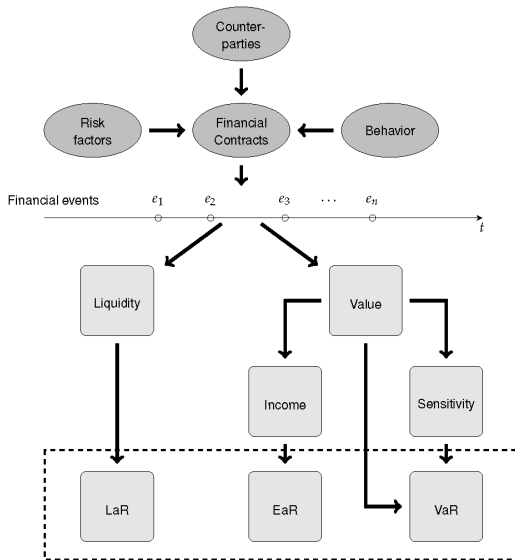
Operational: Operational actions linked to processes, people and systems that cause financial losses.

Additional risk categories?

Example liquidity risk:

- No liquidity risk because liquidity is not a cause but an effect of risk.
- Market, credit, insurance and operation risk factors are causes that affect liquidity, value and income.

└ Risk factors and risk categories



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Time and calendar time

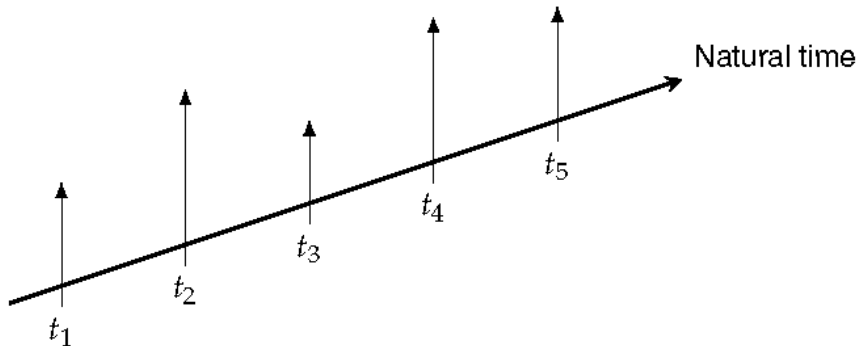
- Banking consists of cash flow exchange pattern along the time line.
- Representation of time in form of a general calendar defining every single day into a meaningful future horizon (50 ~ 200 years)
- Elementary time step: **daily**.
(Up to now, no intra-day settlement)

Time intervals

- Need for **higher than daily time intervals** like monthly and yearly. (E.g. for gap analysis for insurance company with business reaching 50 years from now)
- Also needed for long term simulations
- For liquidity analysis, however, daily time steps are required

Double existence of time

- On the one hand, a financial institution closes every day deals which affect future cash flows up to 50 years and sometimes longer.
- On the other hand, deals are made for a given investment horizon.



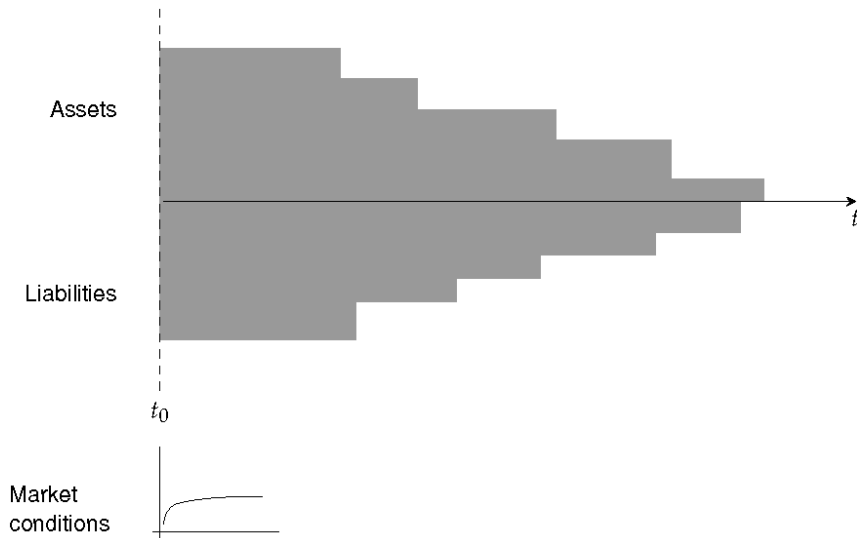
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Analysis types: Two views

- Liquidation view
- Going concern view

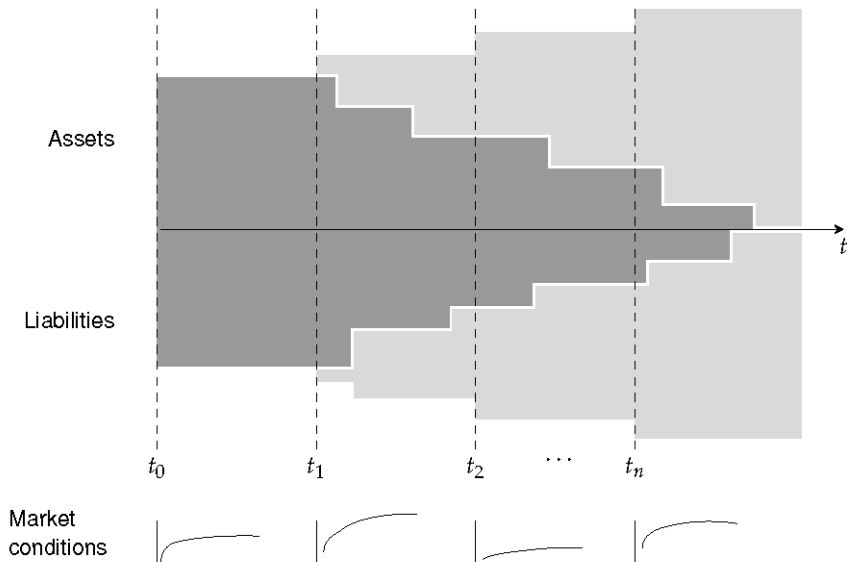
Analysis types: Liquidation view



Analysis types: Liquidation view

- The assets and liabilities at analysis date t_0 are stacked depending on their term to maturity.
- The longer the term to maturity the closer the asset or liability is to the x -axis.
- Over time these assets and liabilities mature without being renewed and the balance sheet tends to zero.
- Only the market conditions at t_0 relevant to the analysis.

Analysis types: Going concern view



Analysis types: Going concern view

Two notable differences:

- 1 Position is not tending to zero.
 - ★ Maturing assets and liabilities replaced by roll overs or new loans and deposits
 - ★ In addition, new business generated which leads to a growing balance sheet.
- 2 Market conditions no longer the forward market derived from prices observed at t_0 .
 - ★ Market conditions forecasted using a simulation schedule.
 - ★ Prevailing market conditions assigned to new or rolled over business in the relevant simulation interval.

Overview over analysis types

	Liquidation view		Going-concern view
	Expected behavior	Shocked behavior	
Expected market	Type I	Type II	Type IV
Shocked market	Type II	Type II	Type IV
Dynamic market	Type III	Type III	Type V

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Unified Financial Analysis in R — What is missing

To be discussed

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Willi Brammertz, Ioannis Akkizidis, Wolfgang Breymann, Rami Entin, and Markus Rüstmann:

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