From Physics to Finance

XXXIII Heidelberg Physics Graduate Days

Heidelberg, October 6th, 2014

Agenda

- » The banks' role in the economy
- » Time series in finance – non linearity and the prediction of the future
- » The mechanics of the balance sheet – an engineers approach
- » The costs of the crisis
- » Is the financial complexity manageable?

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The banks’ role in the economy

The „Banks“

Deutsche Bank

COMMERZBANK

Photo source: © NH1977 / PIXELIO

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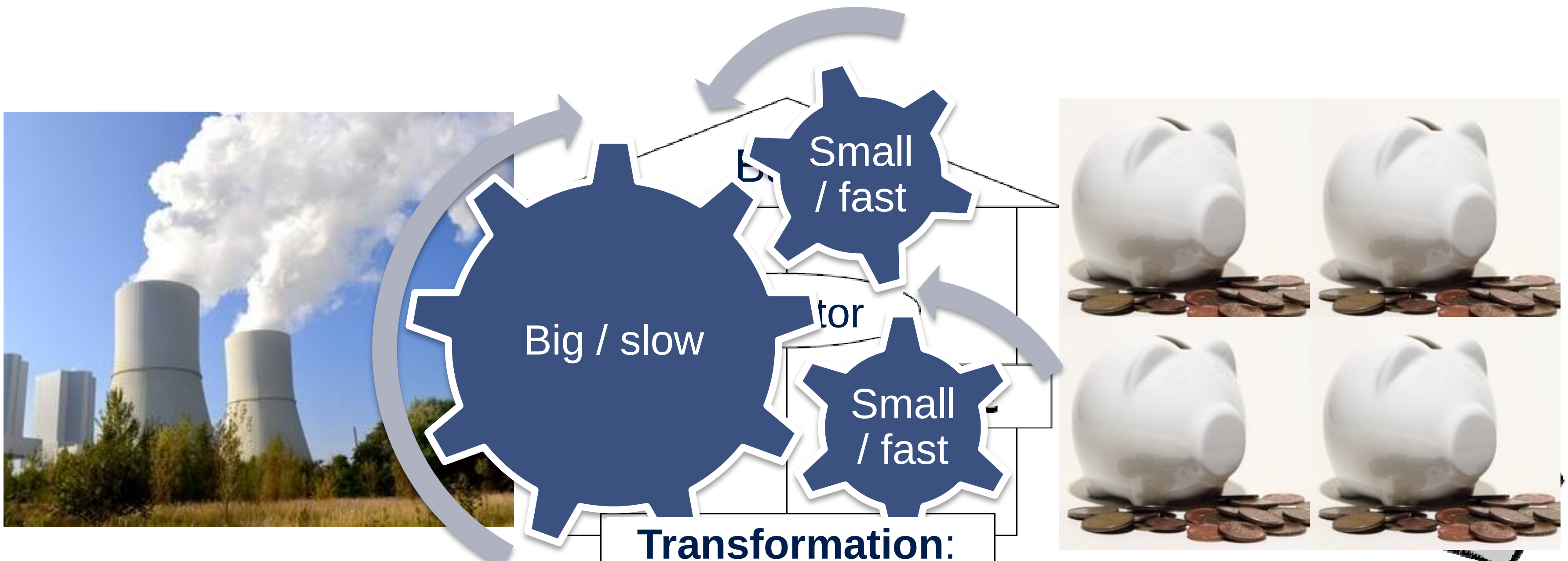
The banks' role – Transforming money



Capital demand:
big, long term demanded capital amounts

Transformation:
- Quantity
- Term
- Risk

Capital supply:
many small, rather short term supplied capital amounts

Transformation is at the heart of banking business

Photo source: © segavax, Andreas Hermsdorf / PIXELIO

Traditional tasks of a bank

Capital / Liquidity transformation

- **Volume transformation**
- **Term transformation**

Risk taking

Information offset

Both forms of transformation hold specific risks for the bank which need to be quantified and controlled:

» Volume transformation ↔ Credit Risk

» Term transformation ↔ Liquidity Risk and Interest Rate Risk

» Currency transformation ↔ FX Rate Risk

» Equity Prices, Stock Exchange Rates, …

Transformation is at the heart of banking business

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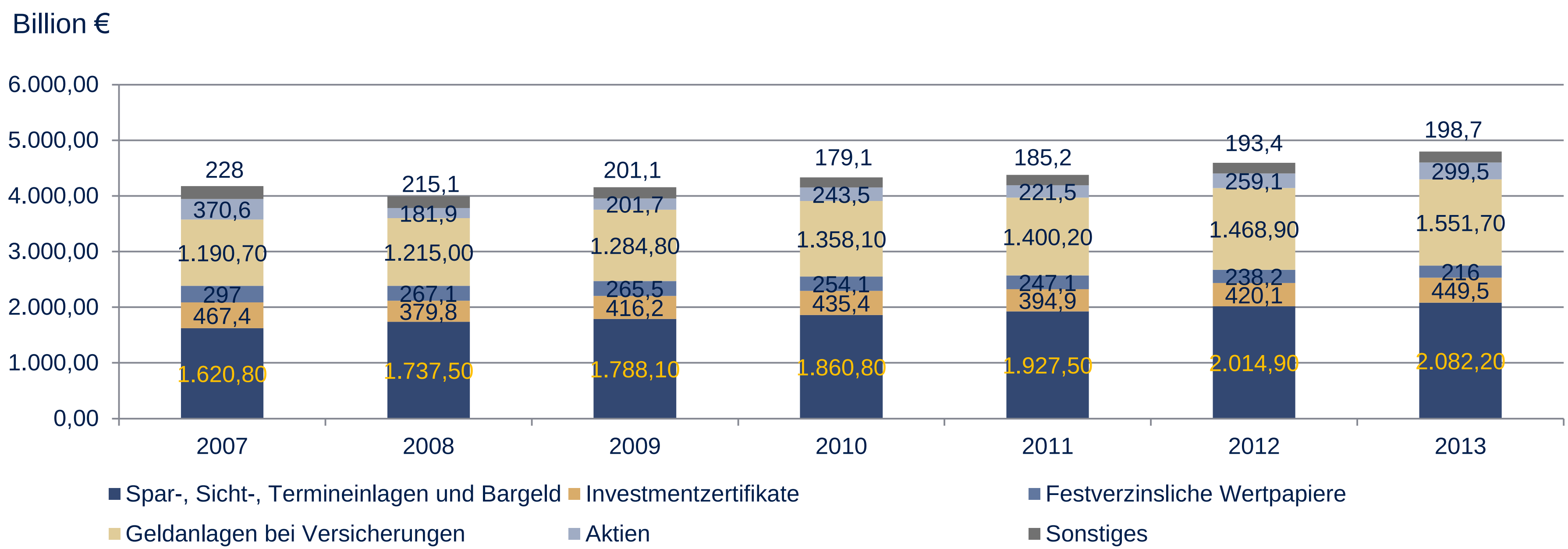
German saving behavior

Germans still invest the largest part of their capital in savings- / sight- / term-deposits and cash, as well as insurances



Source: Deutsche Bundesbank, September 2014

We have savings of about 5 trillion EUR

Banking landscape in Germany

three pillars

Universalbanken (1.813)			
297	Kreditbanken	4	Großbanken
		179	Regionalbanken und sonstige Kreditbanken
		114	Zweigstellen ausländischer Banken
1.083	Genossenschaftliche Kreditinstitute	1.081	Kreditgenossenschaften
		2	Genossenschaftliche Zentralbanken
433	Öffentlich-rechtliche Kreditinstitute	417	Sparkassen
		9	Landesbanken

Spezialbanken (59)	
22	Bausparkassen
17	Realkreditinstitute
21	Banken mit Sonderaufgaben

Source: Bankenstatistik, Statistisches Beiheft 1 zum Monatsbericht, Deutsche Bundesbank, September 2014

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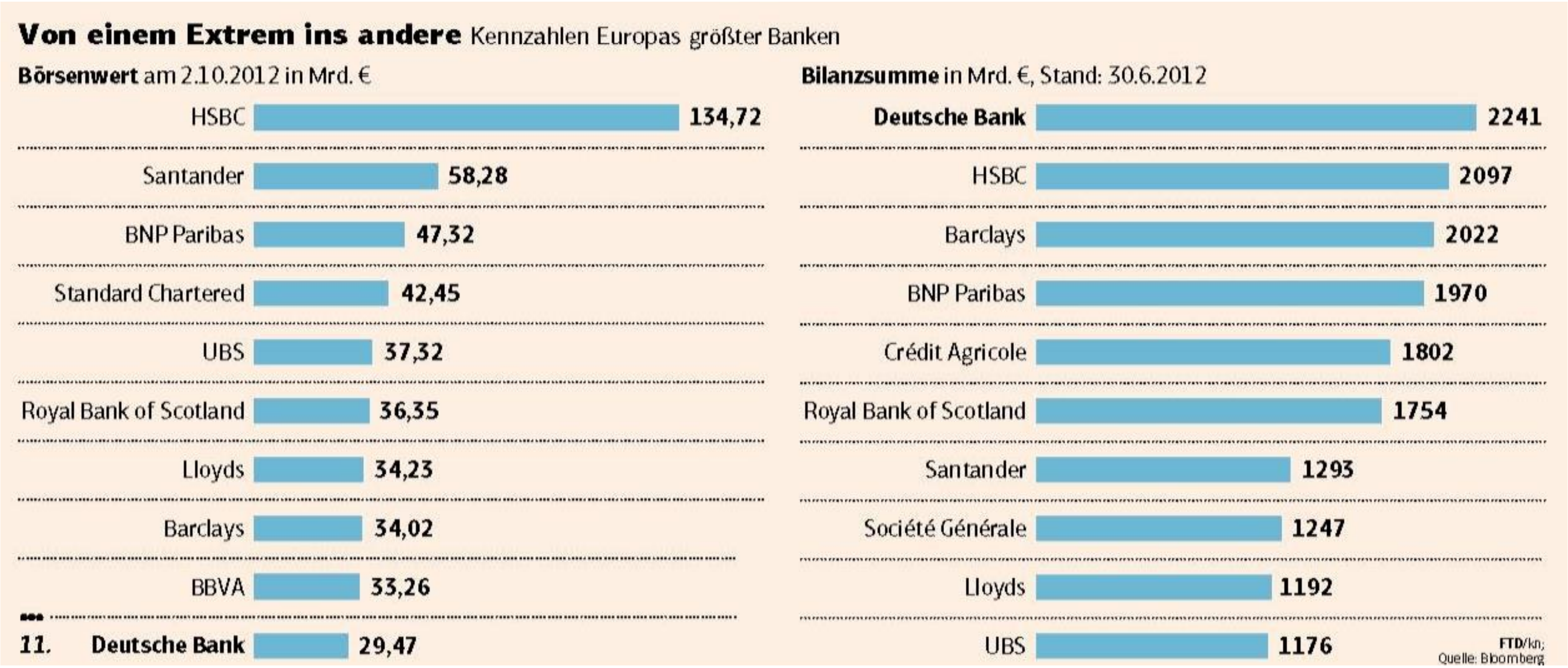
Big banks in Europe



Banks process money in various ways

Source: FTD, 04.10.2012

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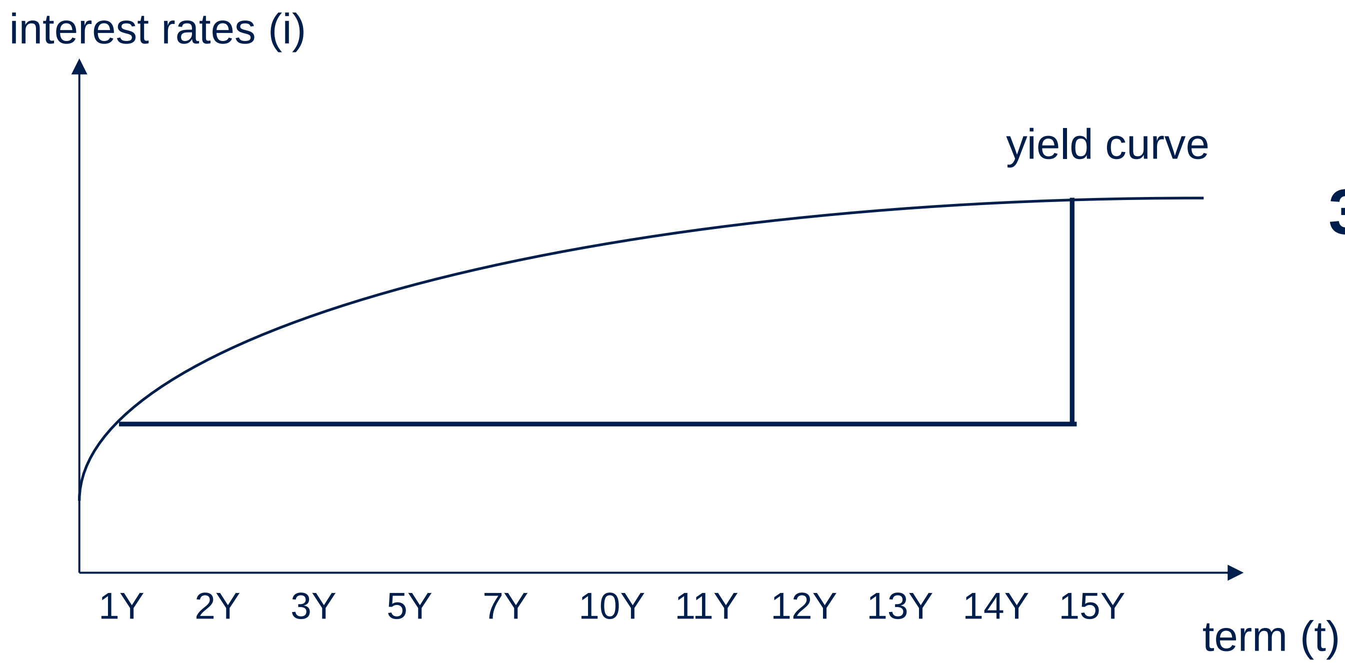
Time series in finance – non-linearity and prediction of the future

The yield curve



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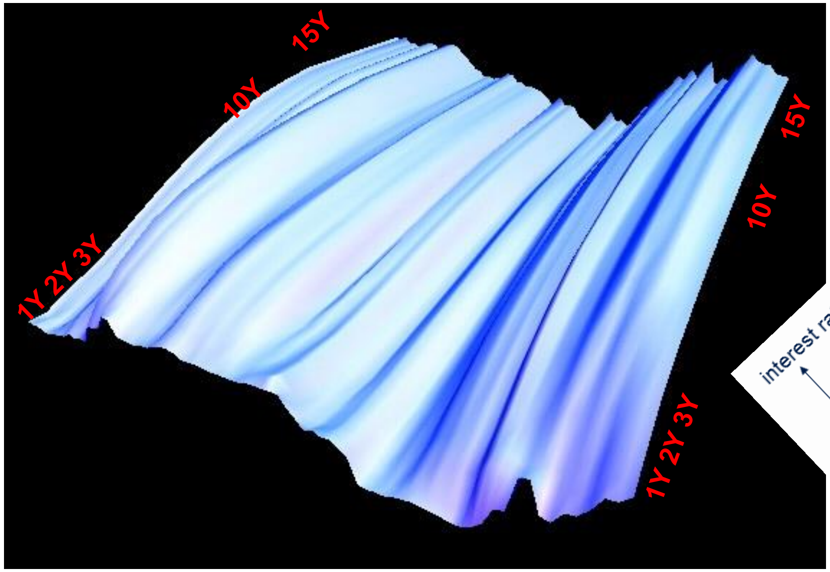
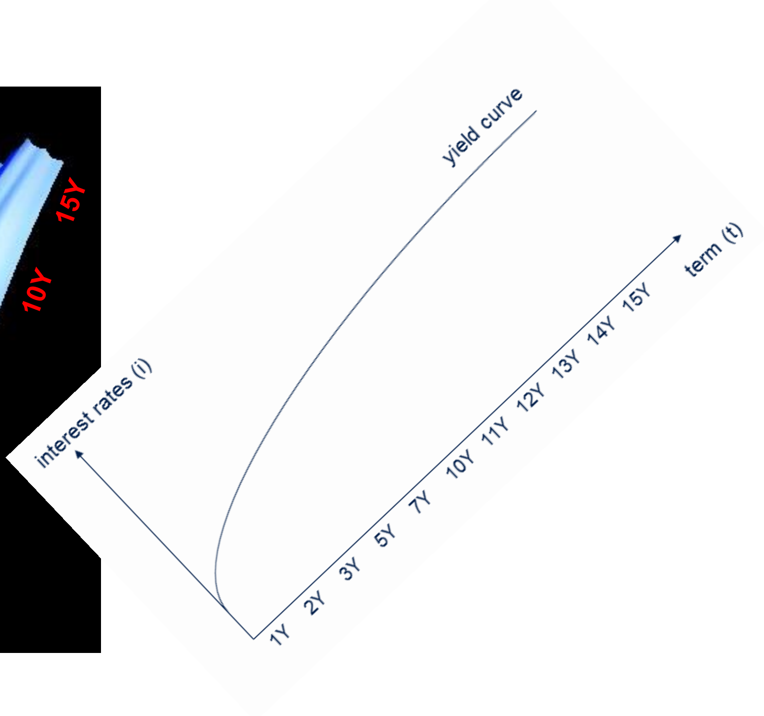
Term transformation, i.e., transformation in time, is a major transformation

Interest rates and their dynamics

05.97 05.98 05.99 05.2000



05.97 05.98 05.99 05.2000



The interest rate curve change in various ways

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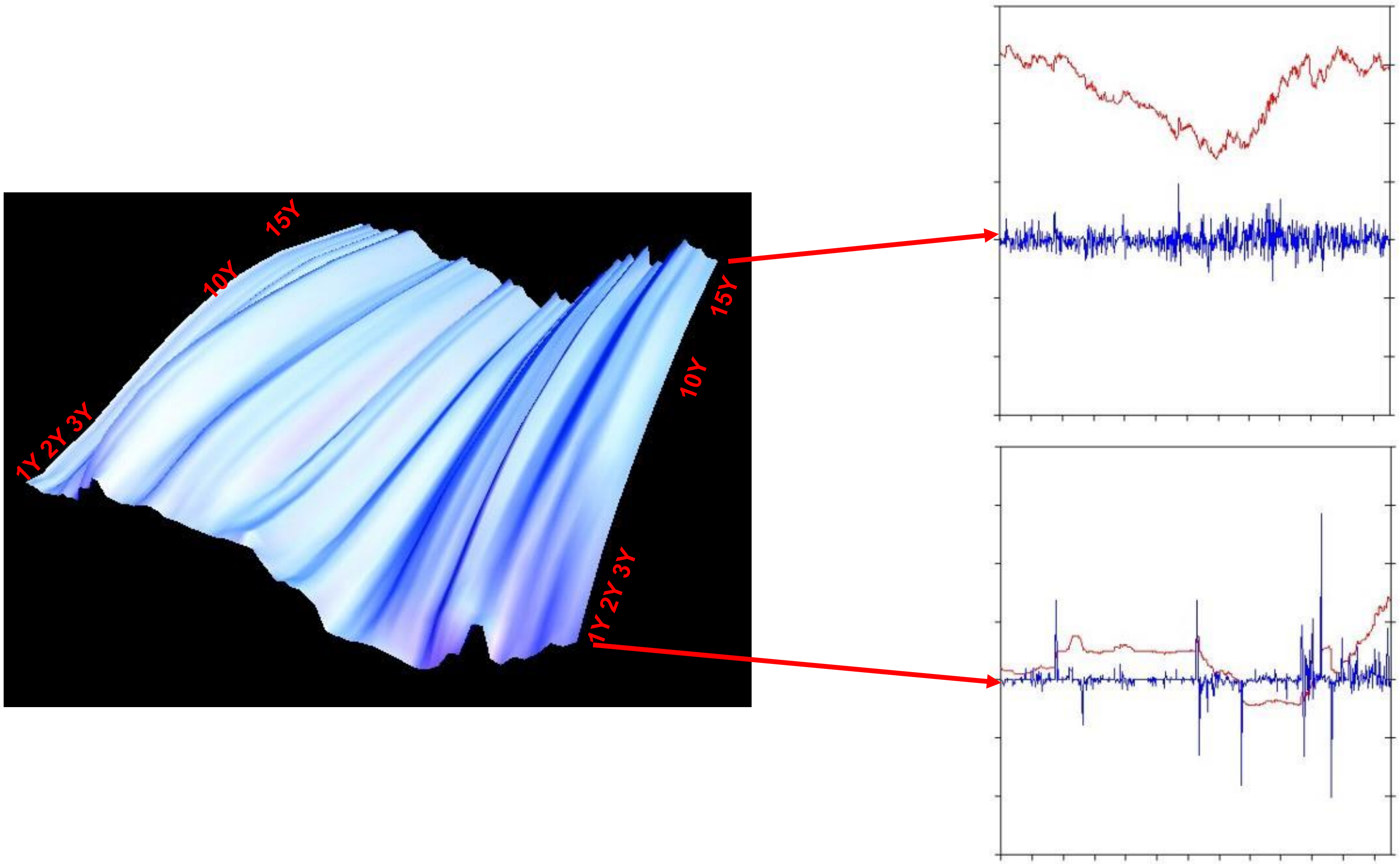
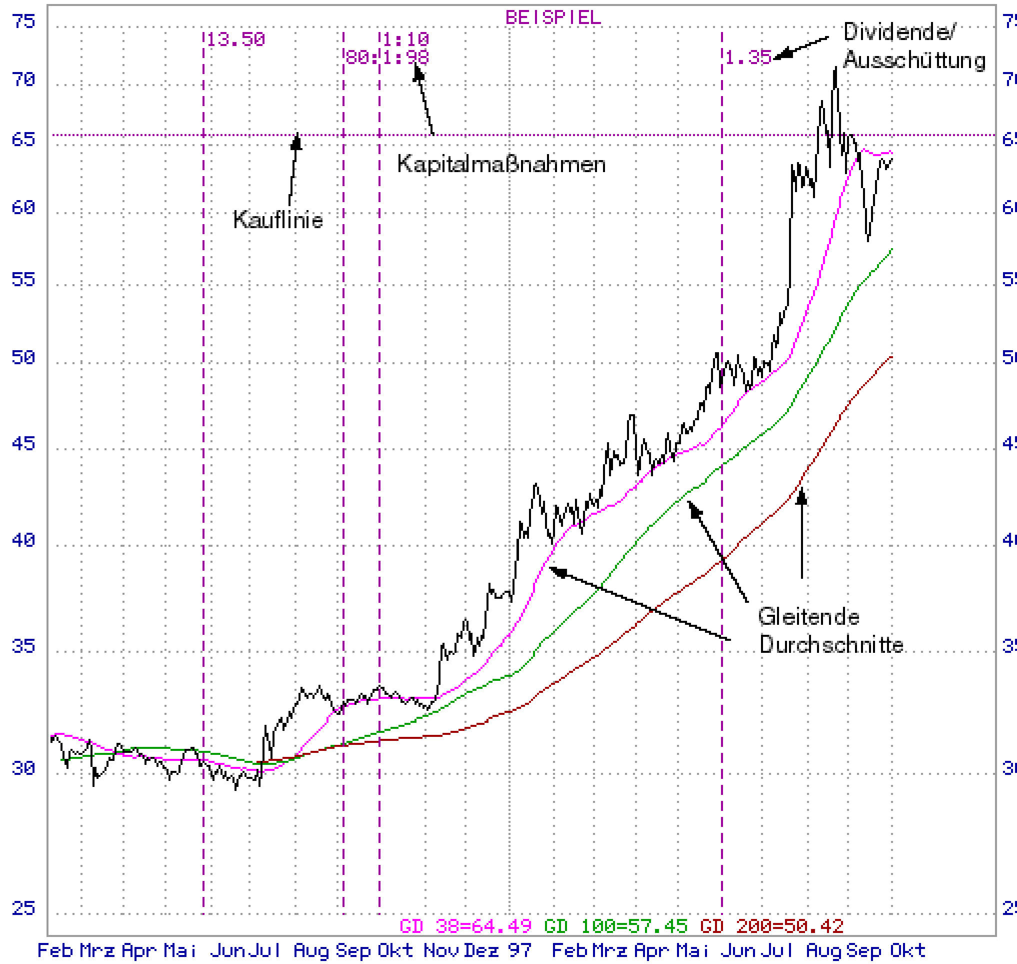
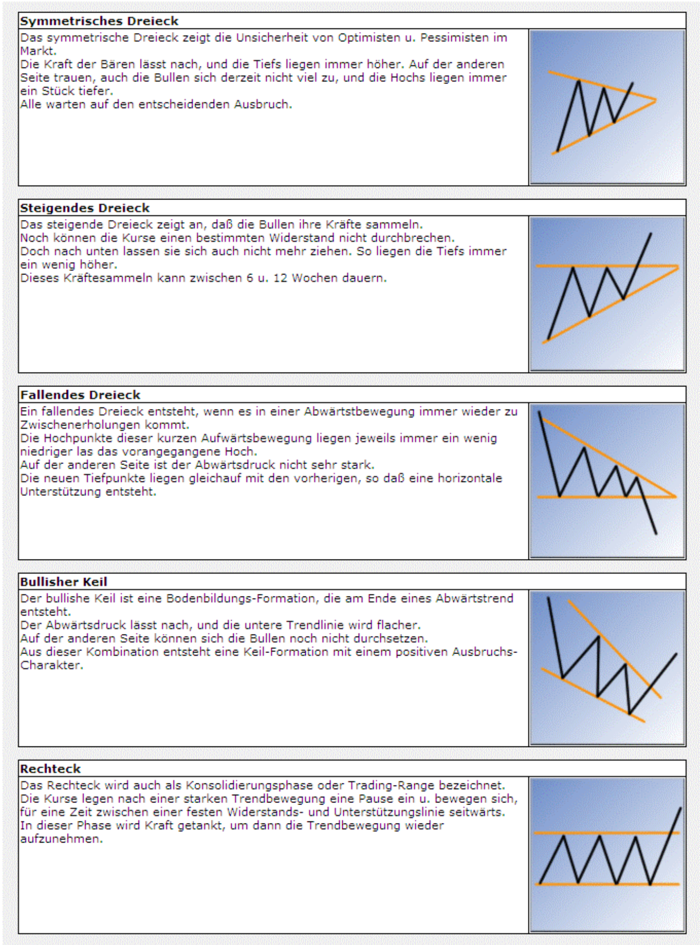
Interest rates and their dynamics



The change in interest rates follows no simple statistics

How to “explain” the curves – different approaches





The “Euclidean geometry” approach

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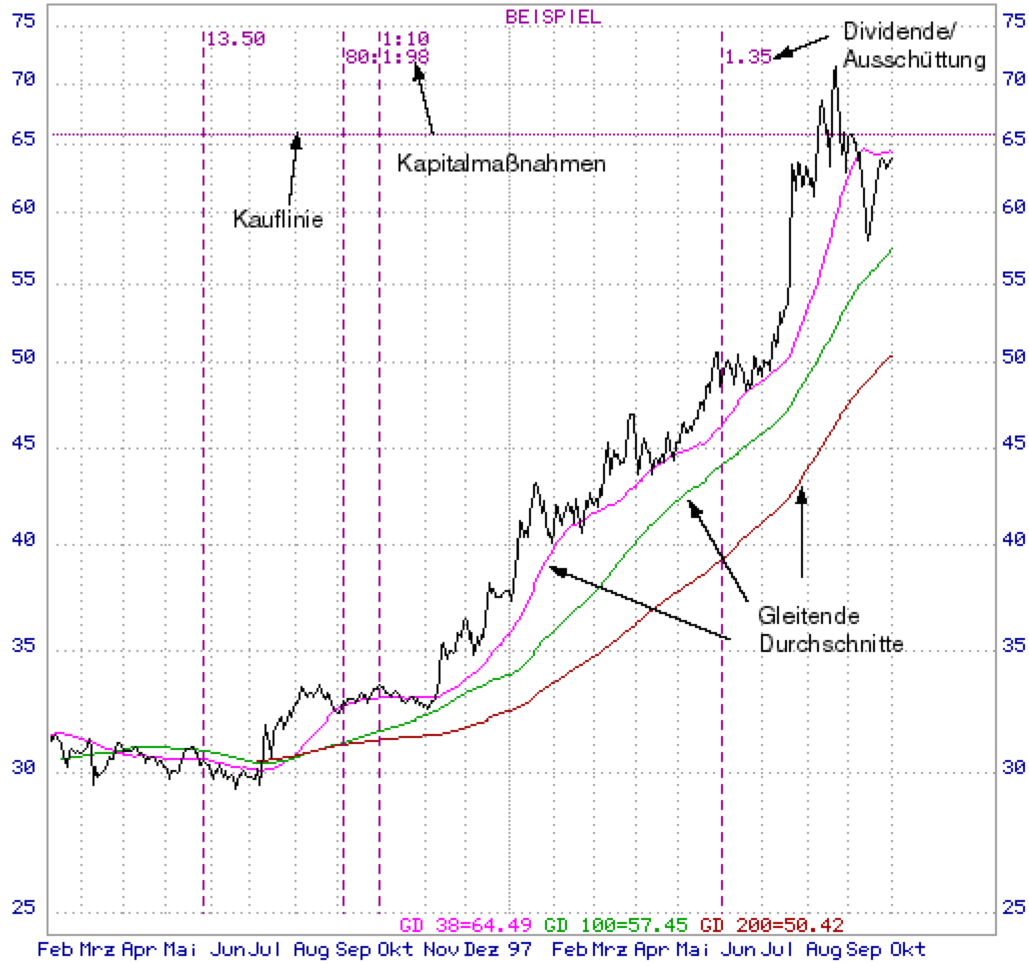
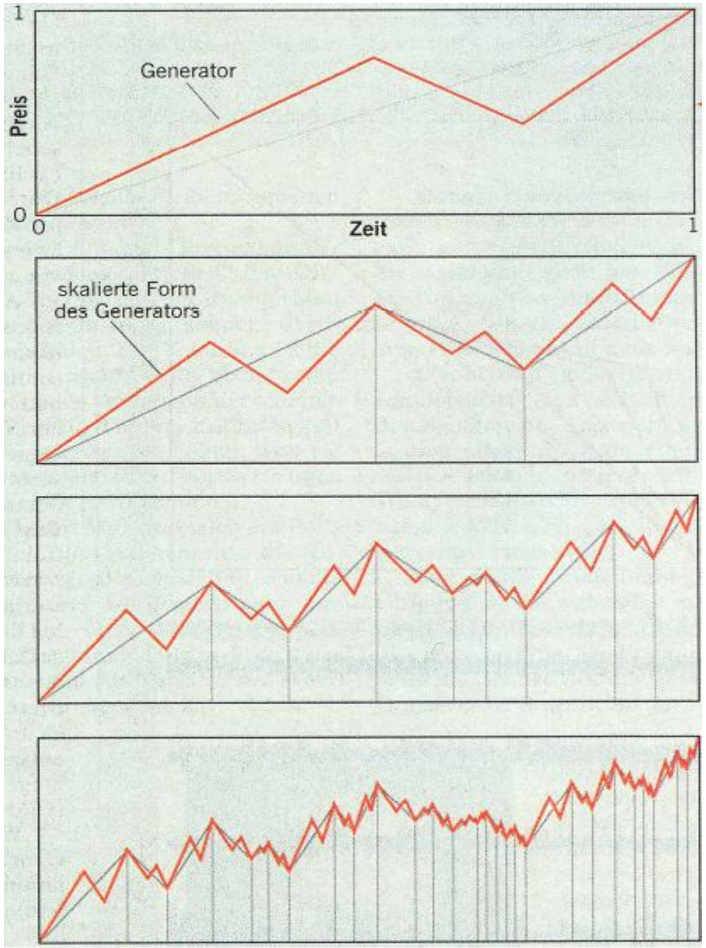
How to "explain" the curves – different approaches





The fractal geometry approach

How to "explain" the curves – different approaches

Welche Kurve ist die gefälschte?

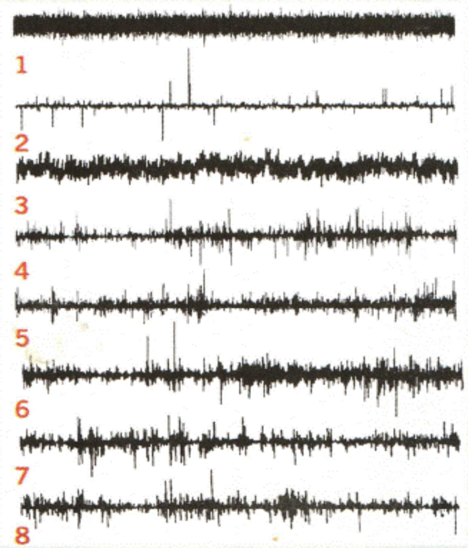
Wie gut können Multifraktale echte Preis-Charts wiedergeben? Vergleichen wir mehrere historische Preisverläufe mit ein paar künstlichen Modellen.

Die erste Kurve ist offensichtlich noch weit von der Realität entfernt. Sie ist außerordentlich einförmig und läuft auf einen konstanten Hintergrund kleiner Preisänderungen hinaus, wie das Rauschen beim Radioempfang. Die Volatilität bleibt gleichförmig, ohne plötzliche Sprünge. Wenn das die Aufzeichnung eines historischen Preisverlaufs wäre, würden sich die Veränderungen zwar von Tag zu Tag unterscheiden, aber die Monate würden insgesamt doch sehr gleichartig verlaufen.

Die ziemlich einfache zweite Kurve ist schon besser, denn sie zeigt viele plötzliche Zacken. Aber die stehen isoliert gegen einen unveränderlichen Hintergrund, in dem die Variabilität der Preise ungefähr gleich bleibt. Das ist bei der dritten Kurve besser getroffen; dafür zeigt sie keine urplötzlichen Sprünge.

Alle drei Diagramme sind mit bloßem Auge als unrealistisch zu erkennen. Woher stammen sie? Kurve 1 folgt einem Modell, das der französische Mathematiker Louis Bachelier (1870 bis 1946) im Jahre 1900 eingeführt hat. Die Preisveränderungen folgen einer Irrfahrt (*random walk*); dazu gehört die Glockenkurve, womit das Modell auf die Portfolio-Theorie hinausläuft. Die Kurven 2 und 3 ergeben sich aus Verbesserungsversuchen von Bacheliers Arbeiten. Die eine entspricht einem Modell, das ich 1963 vorgeschlagen habe (basierend auf Lévy-stabilen Zufallsprozessen) und einem, das ich 1965 publiziert habe (basierend auf *fractional Brownian motion*). Beide sind nur unter sehr speziellen Marktbedingungen sinnvoll.

Von den – wichtigeren – fünf unteren Diagrammen beruht wenigstens eines auf echten Marktdaten, und wenigstens ein weiteres ist ein computergeneriertes Beispiel meines letzten multifraktalen Modells. Bevor Sie weiterlesen, versuchen Sie, diese Charts richtig zuzuordnen! Ich hoffe, daß auch Sie auf die Fälschungen hereinfallen.



Tatsächlich sind nur zwei der Charts echte Marktdaten. Chart 5 stellt den Kurs der IBM-Aktie dar und Chart 6 den Wechselkurs DM gegen amerikanische Dollar. Die anderen Kurven (4, 7 und 8) ähneln ihren zwei echten Gegenstücken zwar stark, sind aber vollständig künstlich, erzeugt mit einer weiter verfeinerten Form meines multifraktalen Modells.

The fractal geometry approach

Source: B. B. Mandelbrot, Börsenturbulenzen neu erklärt, Spektrum der Wissenschaft, Mai 1999, 74-77

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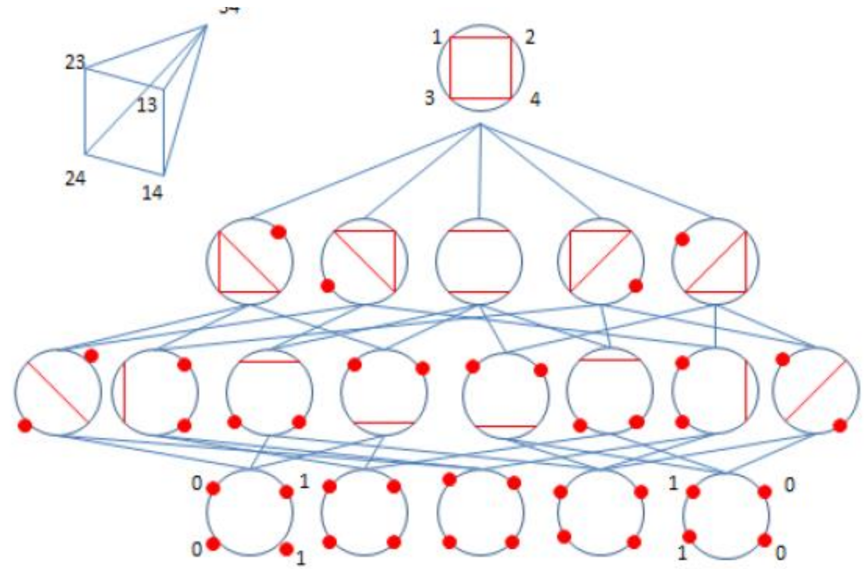
Crossing Stocks and the Positive Grassmannian I: The Geometry behind Stock Market

Ovidiu Racorean

Removals of crossings in the permutation associated to stock market reside in the decomposition of the positive Grassmannian $G^{+}(2,4)$ labeled by the stock market polytope in positroid cells as is depicted in the figure 11.



The combinatorial approach

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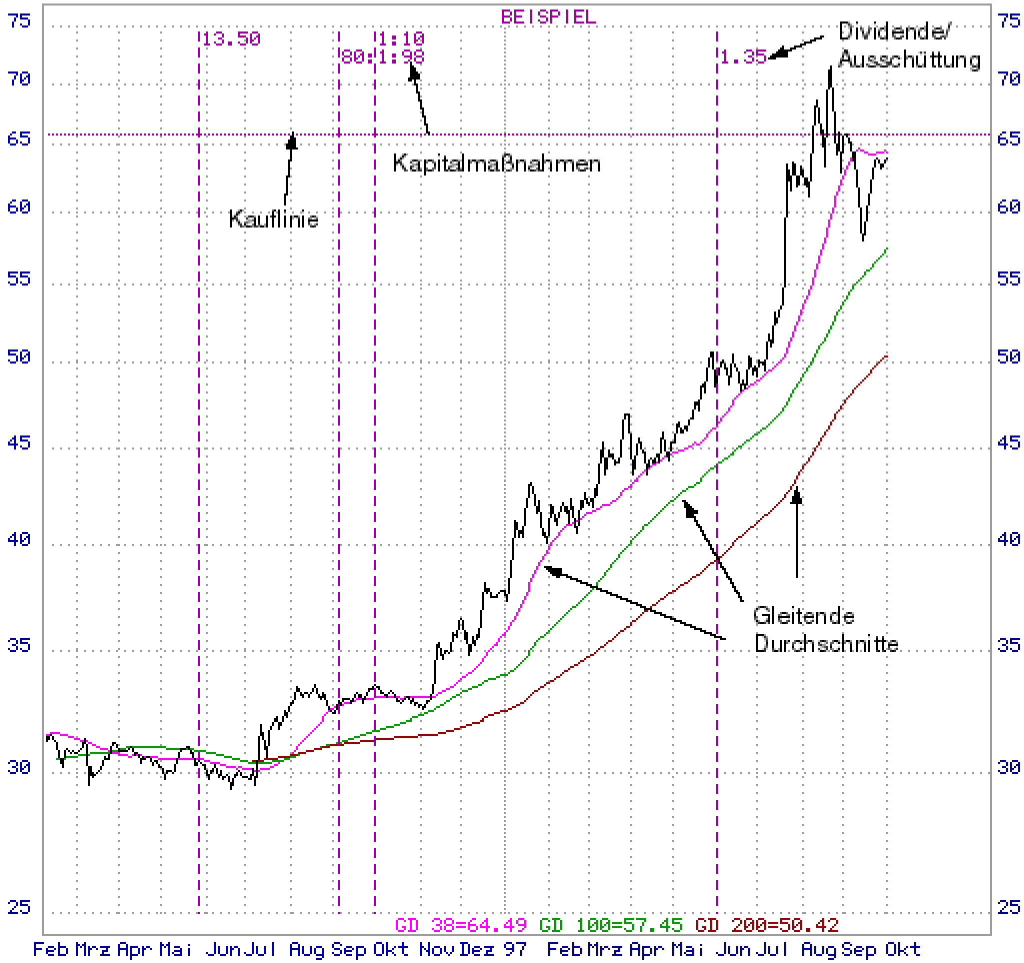
How to “explain” the curves – different approaches



Mean–Reverting–Process

$$dX_t = \mu(X_t)dt + \sigma(X_t)dB_t$$
$$for\ t \geq 0, X_0 = x_0 \in I$$
$$\mu(x) = \beta + \alpha x, \forall x \in I, \alpha \in R^-, \beta \in R$$
$$\sigma(x) > 0, \forall x \in I$$

Ornstein – Uhlenbeck – Process

$$dX_t = \mu(X_t)dt + \sigma(X_t)dB_t$$
$$for\ t \geq 0, X_0 = x_0 \in R$$
$$\mu(x) = \alpha x, \forall x \in R, \alpha \in R^-$$
$$\sigma(x) = \sigma, \sigma \in R^+$$

Vasicek – Model

$$dX_t = \mu(X_t)dt + \sigma(X_t)dB_t$$
$$for\ t \geq 0, X_0 = x_0 \in R$$
$$\mu(x) = \beta + \alpha x, \forall x \in R, \alpha \in R^-, \beta \in R$$
$$\sigma(x) = \sigma, \sigma \in R^+$$

Cox – Ingersoll – Ross – Model

$$dX_t = \mu(X_t)dt + \sigma(X_t)dB_t$$
$$for\ t \geq 0, X_0 = x_0 \in R^+$$
$$\mu(x) = \beta + \alpha x, \forall x \in R^+, \alpha \in R^-, \beta \in R^+$$
$$\sigma(x) = \sigma\sqrt{x}, \forall x \in R^+, \sigma \in R^+, 2\beta \geq \sigma^2$$

The stochastic approach

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How to “explain” the curves – different approaches

*	dW_t	dt
dW_t	dt	0
dt	0	0

Ito′s formula

$$df(X_t) = f'(X_t)dX_t + \frac{1}{2}f''(X_t)(dX_t)^2$$

$$var\, W_t = t \qquad Cov(W_t, W_s) = min(s,t)$$

Ito Tanaka formula for local time

$$L_t^a(Z) = |Z_t - a| - |Z_0 - a| - \int_0^t sgn(Z_u - a)dZ_u$$

$$f(Z_t) = F(Z_0) + \int_0^t f'_t(Z_u)dZ_u + \frac{1}{2}\int_R L_t^a(Z), \mu(da)$$

Ito Process

$$dX_t = b_t dt + \sigma_t dW_t$$

The stochastic approach

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How to “explain” the curves – different approaches

Brownian Bridge

$$B_s = W_r + \frac{s-r}{t-r}(W_t - W_r) + \sqrt{\frac{(s-r)(r-t)}{t-r}}N(0,1)$$

Semimartingale: $X_t = M_t + A_t$

Girsanov

$$d\tilde{P} \triangleq exp\left(\sigma W_T - \frac{1}{2}\sigma^2 T\right) dP$$

$\tilde{W}_t - \sigma t$ is a Brownian motion under $\tilde{P}$

Bessel Process

$$dR_t = dW_t + \frac{n-1}{2R_t}dt$$

$$dR_t^2 = 2\sqrt{R_t^2}dW_t + ndt$$

The stochastic approach

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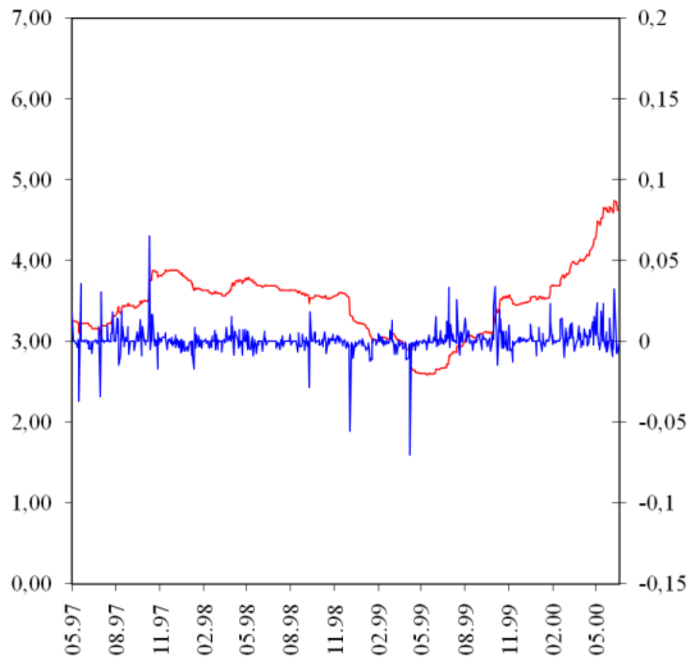
Interest rate models

Basic model: $X_t = \sigma_t Z_t$ with

$\{Z_t\}$ is IID with mean 0, variance 1, e.g. N(0,1)
very simple: fixed σ, more advanced: $\{\sigma_t\}$ is a volatility process



GARCH model

$X_t = \sigma_t Z_t$

GARCH(p,q) process (General AutoRegressive Conditional Heteroscedastic)

$$\sigma_{\mathrm{t}}^2 = c_0 + c_1 X_{\mathrm{t-1}}^2 + \cdots + c_p X_{\mathrm{t-p}}^2 + \beta_1 \sigma_{\mathrm{t-1}}^2 + \cdots + \beta_q \sigma_{\mathrm{t-q}}^2 \quad .$$

Special case ARCH(1)

$$\begin{aligned} X_{\mathrm{t}}^2 &= (c_0 + c_1 X_{\mathrm{t-1}}^2) Z_{\mathrm{t}}^2 \\ &= c_1 Z_{\mathrm{t}}^2 X_{\mathrm{t-1}}^2 + c_0 Z_{\mathrm{t}}^2 \\ &= A_{\mathrm{t}} X_{\mathrm{t-1}}^2 + B_{\mathrm{t}} \end{aligned}$$

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Stochastic volatility models

$X_t = \sigma_t Z_t$

σ_t is a second process, independent of Z_t

Model for the volatility (Taylor 1986)

$$\log \sigma_t^2 = \alpha_0 + \alpha_1 \log \sigma_{t-1}^2 + \alpha_2 \varepsilon_t, \ \{\varepsilon_t\} \sim \mathrm{IID}\, \mathrm{N}(0,1)$$

Stochastic recurrence model

$$X_t = X_{t-1}\varepsilon_t + \eta_t \ \text{mit} \ \{\varepsilon_t, \eta_t\} \sim \mathrm{IID}$$

Extensions to the basic GARCH model

General formula: $r_t = \sigma_t \varepsilon_t$

Bilinear (Granger / Andersen 1978): $\sigma_t{}^2 = r_{t-1}{}^2$

ARCH(1, 1) (Engle 1982): $\sigma_t{}^2 = c_0 + c_1 r_{t-1}{}^2$

GARCH(1, 1) (Bollerslev 1986): $\sigma_t{}^2 = c_0 + c_1 r_{t-1}{}^2 + c_2 \sigma_{t-1}{}^2$

EGARCH (Nelson 1990):

$$\log(\sigma_t) = c_0 + c_1 \log(\sigma_{t-1}) + \frac{c_2 \varepsilon_{t-1}}{\sqrt{\sigma_{t-1}}} + c_3 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}}} - \sqrt{\frac{2}{\pi}} \right)$$

Further: ARCH-M, AARCH, NARCH, PARCH, PNP_ARCH, STARCH, SWARCH, Component-ARCH, IARCH, multiplicative ARCH

For weather derivatives e.g. the ARFIMA-FIGARCH approach is used

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Physical models applied to financial markets - A string model in Phynance

From the currency rate quotations onto strings and brane world scenarios

D. Horváth R. Pincak

We are currently in the process of transfer of modern physical ideas into the neighboring field called econophysics. The physical statistical view point has proved fruitful, namely, in the description of systems where many-body effects dominate. However, standard, accepted by physicists, bottom-up approaches are cumbersome or outright impossible to follow the behavior of the complex economic systems, where autonomous models encounter the intrinsic variability.

The "cosmological" approach

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Physical models applied to financial markets

- » The application of stochastic methods to questions from the world of finance is nowadays an established standard.
- » Many well understood paradigms from physics can be applied to problems arising in a financial context. Time will tell which of them will also have practical relevance.
- » Ising models, chaos theory, fractals, etc.

The statistical physics approach

Physical models applied to financial markets

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- Ising models, chaos theory, fractals, etc.

The statistical physics approach

Photo source: La-Liana / pixelio.de

Physical models applied to financial markets - Hamiltonians

Stock markets and quantum dynamics: a second quantized description

F. Bagarello

Tim Reckmann / pixelio.de

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Physical models applied to financial markets - Hamiltonians

Stock markets and quantum dynamics: a second quantized description

F. Bagarello

- Toy model of a stock market based on the following assumptions:
  - Our market consists of L traders exchanging a single kind of share;
  - The total number of shares, N, is fixed in time;
  - A trader can only interact with a single other trader: i.e. the traders feel only a *two-body interaction*;
  - The traders can only buy or sell one share in any single transaction;
  - The price of the share changes with discrete steps, multiples of a given monetary unit;
  - When the tendency of the market to sell a share, i.e. the *market supply*, increases then the price of the share decreases;
  - For our convenience the supply is expressed in term of natural numbers;
  - To simplify the notation, we take the monetary unit equal to 1.

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Physical models applied to financial markets - Hamiltonians

» The *formal* hamiltonian of the model is the following operator:

$$\widetilde{H} = H_0 + \widetilde{H}_l, where$$

$$H_0 = \sum_{l=1}^{L} a_l\, a_l^{\dagger} a_l + \sum_{l=1}^{L} \beta_l\, c_l^{\dagger} c_l + o^{\dagger} o + p^{\dagger} p$$

$$\widetilde{H}_l = \sum_{i,j=1}^{L} p_{ij} \left(a_i^{\dagger} a_j \left(c_i c_j^{\dagger}\right)^{\widehat{P}} + a_i a_j^{\dagger} \left(c_j c_i^{\dagger}\right)^{\widehat{P}} \right) + o^{\dagger} p + p^{\dagger} o$$

» where $\widehat{P} = p^{\dagger} p$ and the following commutation rules are used:

» $\left[a_l, a_n^{\dagger}\right] = \left[c_l, c_n^{\dagger}\right] = \delta_{ln} I \qquad \left[p, p^{\dagger}\right] = \left[o, o^{\dagger}\right] = I$

» All other commutators are zero.

» We further assume that $p_{ii} = 0$

» *Number*, *price*, *cash* and *supply* operators: $a_l^{\sharp}, p^{\sharp}, c_l^{\sharp}, o^{\sharp}$

» The states of the market are: $\omega_{\{n\};\{k\};O;M}(.) = \left\langle \varphi_{\{n\};\{k\};O;M}, \varphi_{\{n\};\{k\};O;M} \right\rangle$

» where $\{n\} = n_1, n_2, \dots, n_L, \{k\} = k_1, k_2, \dots, k_L$ and

$$\varphi_{\{n\};\{k\};O;M} = \frac{\left(a_1^{\dagger}\right)^{n_1} \dots \left(a_L^{\dagger}\right)^{n_L} \left(c_1^{\dagger}\right)^{k_1} \dots \left(c_L^{\dagger}\right)^{k_L} \left(o^{\dagger}\right)^{O} \dots \left(p^{\dagger}\right)^{M}}{\sqrt{n_1! \dots n_L!\, k_1! \dots k_L!\, O!\, M!}} \varphi_0$$

» φ_0 is the vacuum of the model: $a_j \varphi_0 = c_j \varphi_0 = p \varphi_0 = o \varphi_0 = 0, for\ j = 1, 2, \dots, L$

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Physical models applied to financial markets - Hamiltonians

» The time evolution for the observables, e.g., the price

$$\frac{dX(t)}{dt} = ie^{iHt}[H,X]e^{-iHt} = i[H,X(t)]$$

Tim Reckmann / pixelio.de

Physical models applied to financial markets – Selected books

- Baaquie, B. E. (2004). *Quantum finance*. Cambridge University Press.
- Chakrabarti, B. K., Chakraborti, A., & Ghosh, A. (2013). *Econophysics of systemic risk and network dynamics*. Springer.
- Kleinert, H. (2009). *Path integrals in quantum mechanics, statistics, polymer physics, and financial markets*. World Scientific.
- Mandelbrot, B. B. (1997). *Fractals and Scaling in Finance: Discontinuity, Concentration, Risk*. Springer.
- Mantegna, R. N., & Stanley, H. E. (2000). *An introduction to econophysics: correlations and complexity in finance* (Vol. 9). Cambridge: Cambridge university press.
- Wille, L. T. (2010). *New Directions in Statistical Physics: Econophysics, Bioinformatics, and Pattern Recognition*. Springer.

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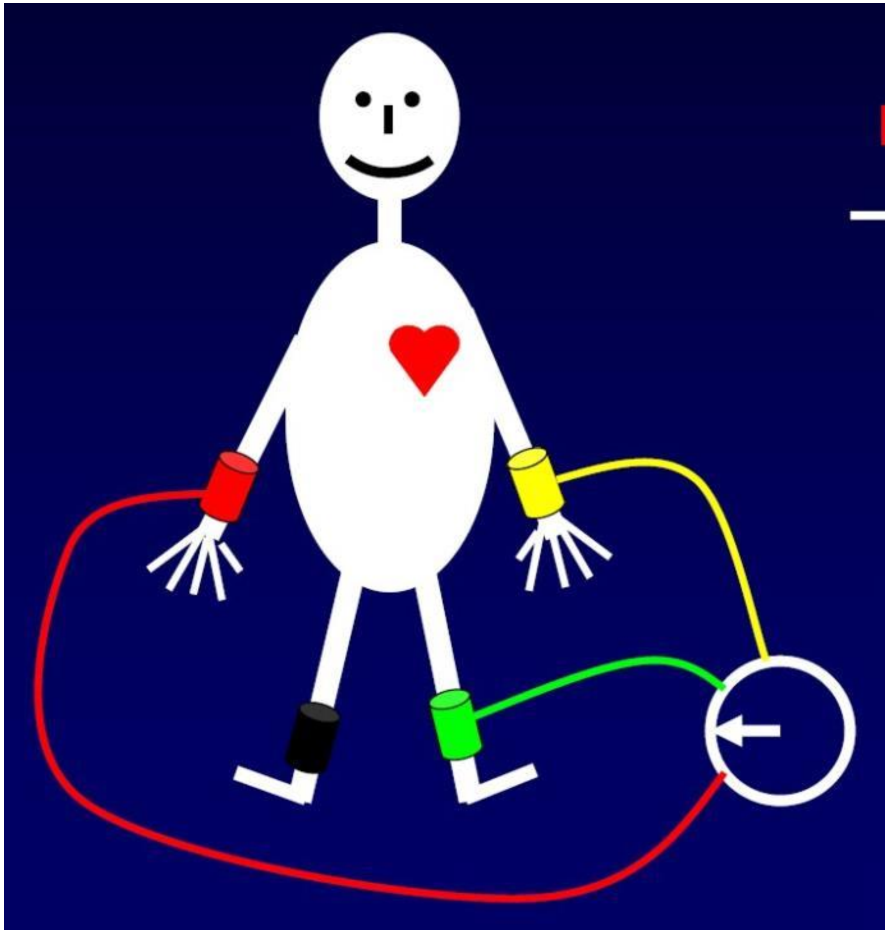
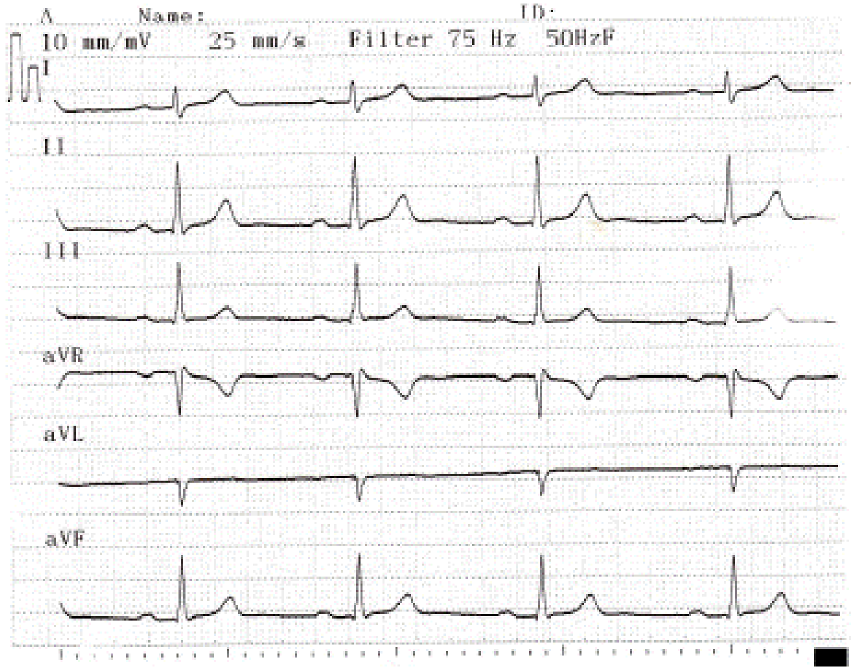
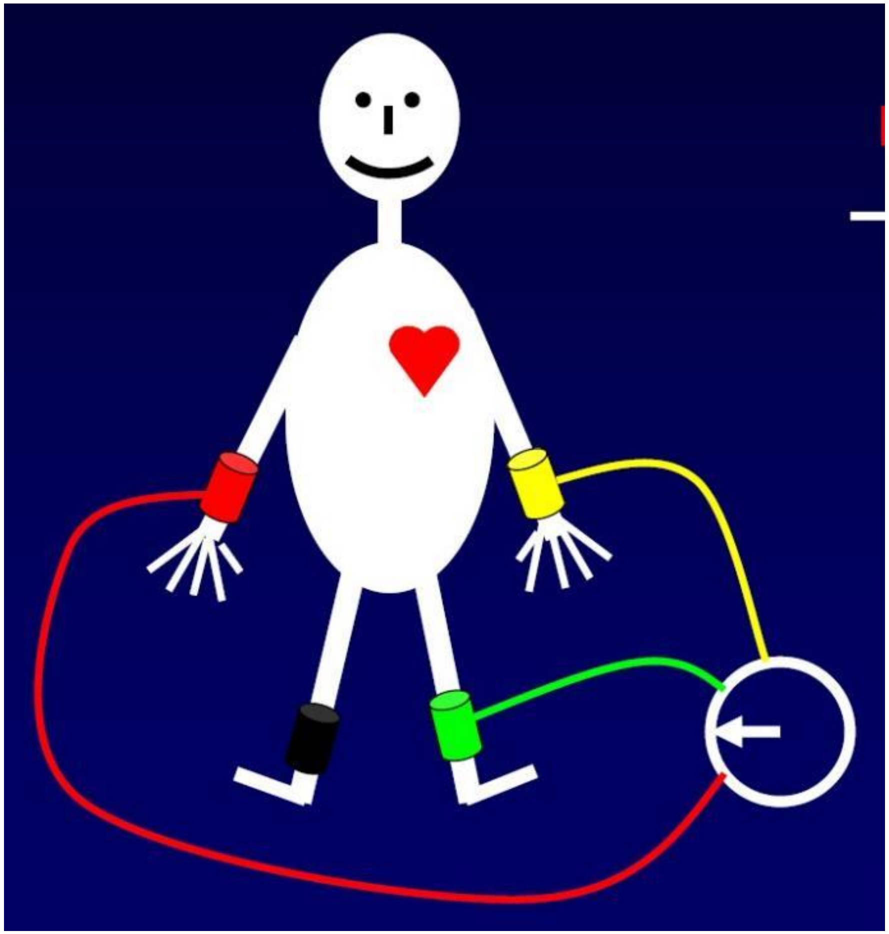
The “patient” financial markets

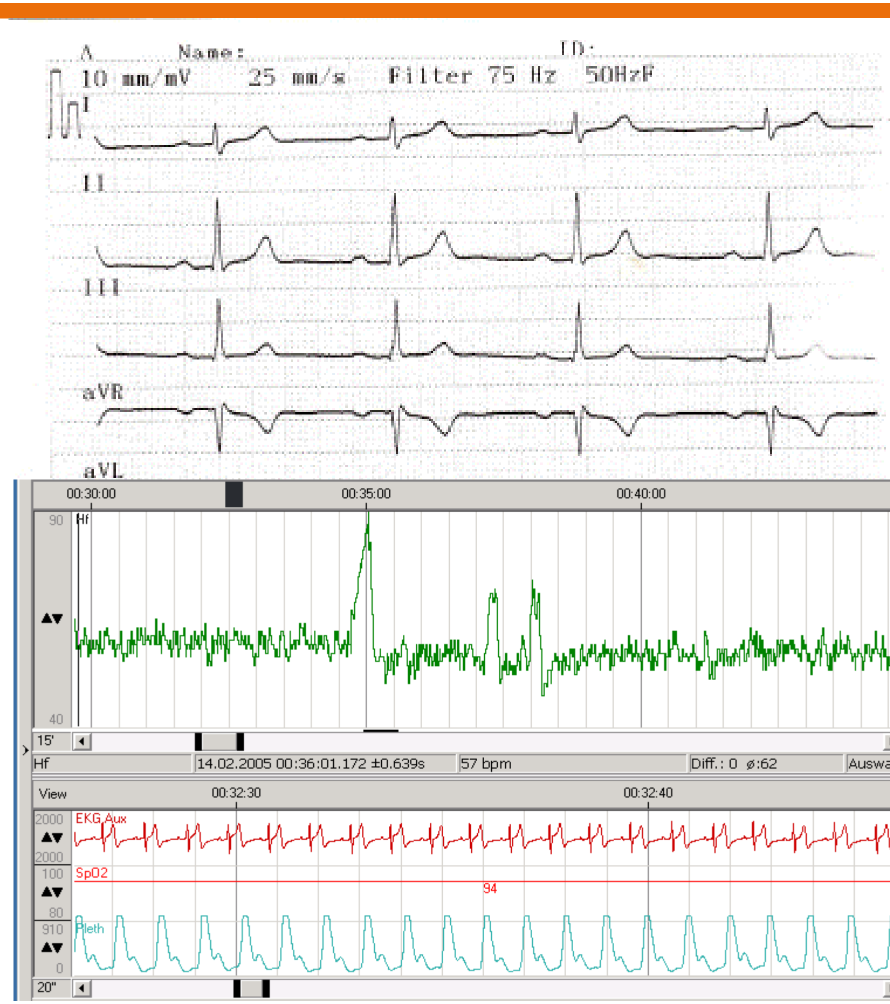




Our models “fit” in various fields of science

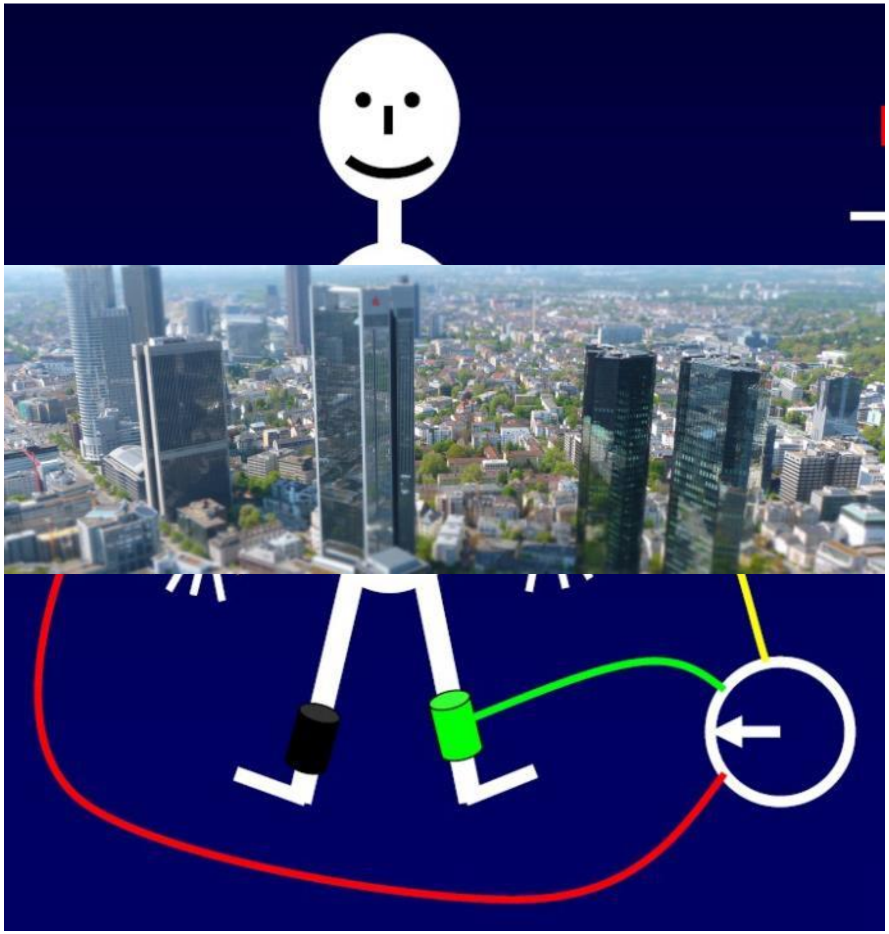
The “patient” financial markets

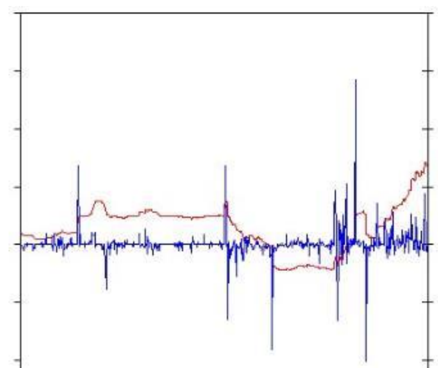




Our models “fit” in various fields of science

The “patient” financial markets





Our models “fit” in various fields of science – exploring mathematical structures via analogy

Photo source: © NH1977 / PIXELIO

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The mechanics of the balance sheet – an engineers approach

Inflows and Outflows

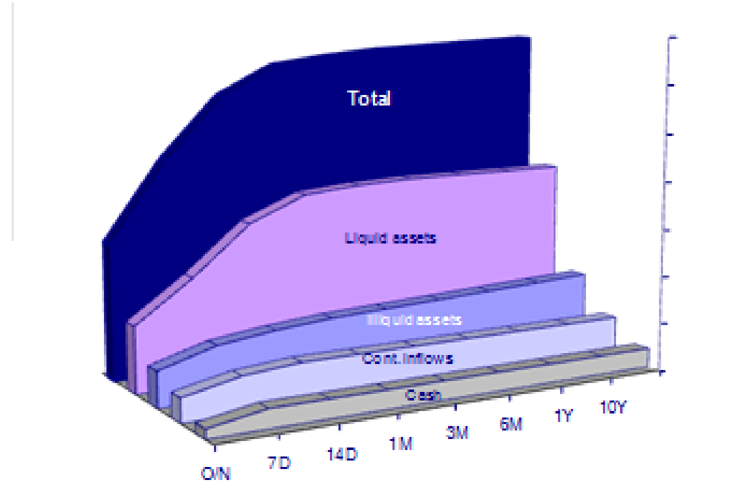
Mechanics of the balance sheet

Stylized Balance Sheet

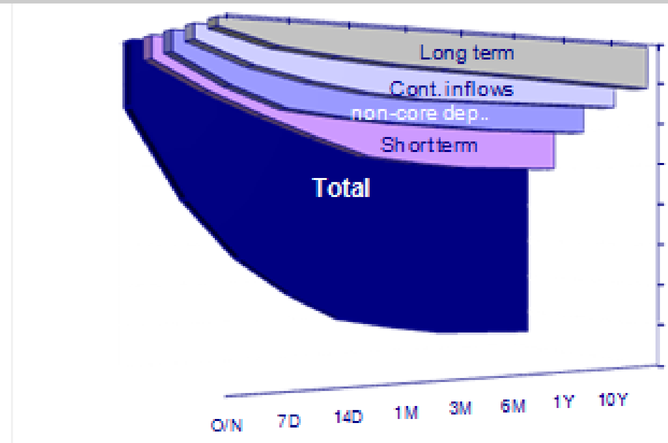
Assets	Liabilities
Cash balance	Short-term funding
Liquid assets (unencumbered)	Non-core deposits
	Core deposits
Illiquid assets	Long-term funding
	Share capital

Averaged balance sheet total of the big German banks: 490 bn Euros

Source: Bundesbankstatistik, July 2011



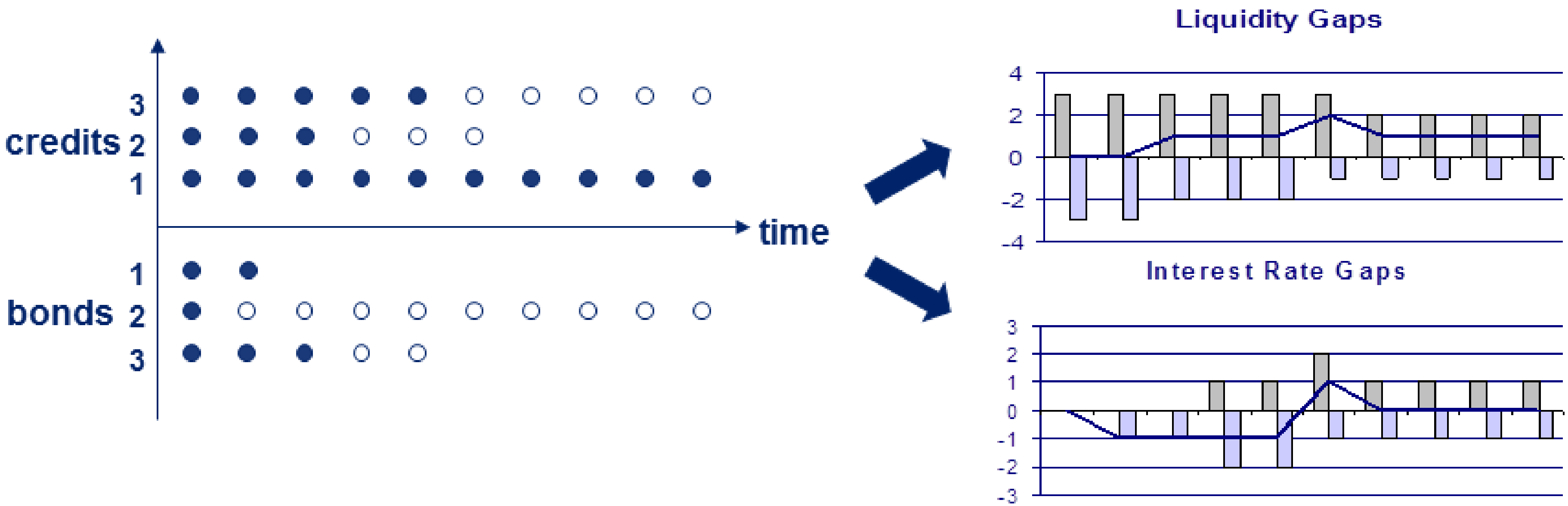
Cumulated outflows (cash ladder)



Counting and labeling monetary units in time

Consolidation: The ball model

- **Purpose:** Simultaneous consideration of interest rate risk and liquidity risk



- ○ … capital commitment, no interest rate commitment
- ● … capital and interest rate commitment

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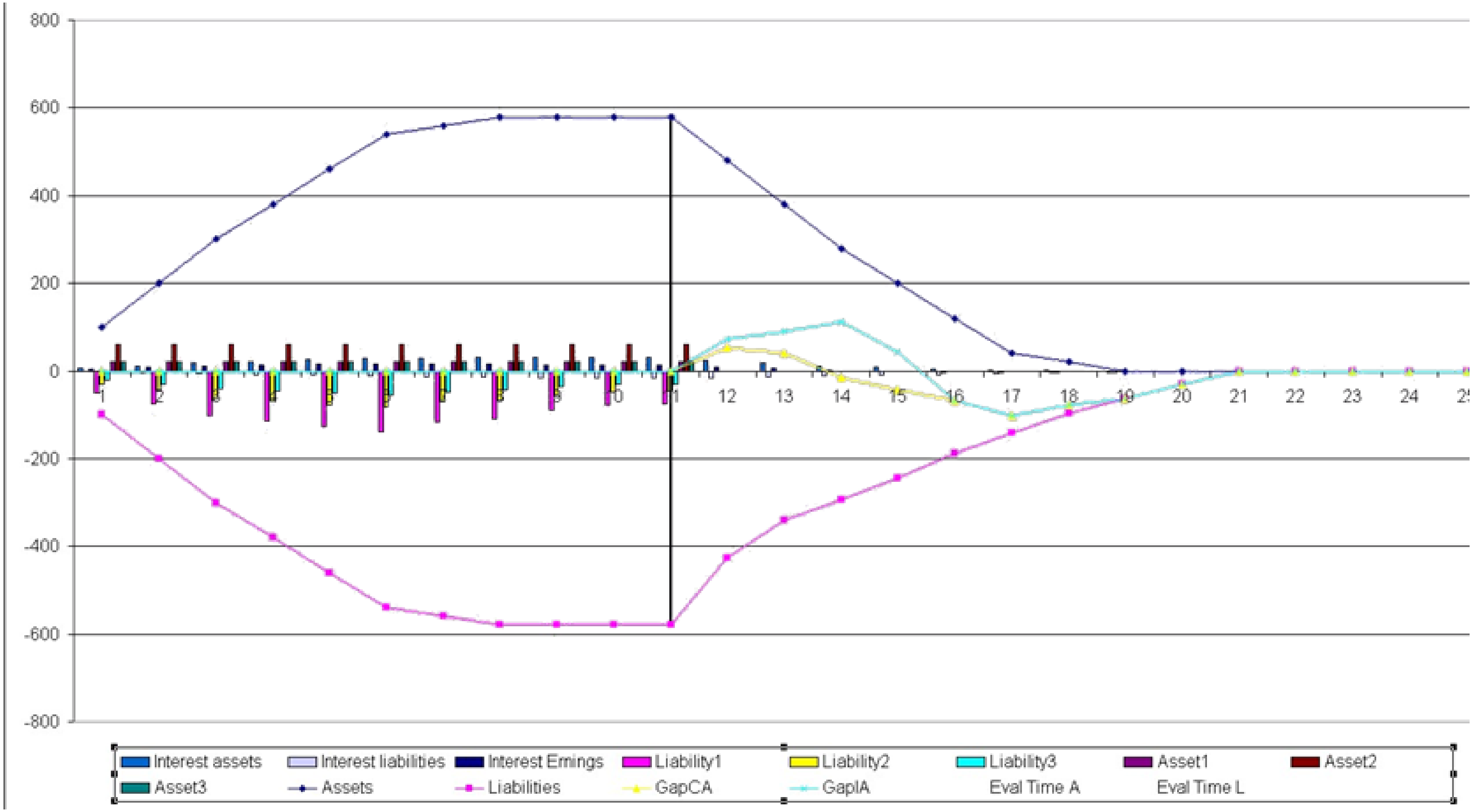
The “bow wave” of the balance sheet

Consolidation: The ball model



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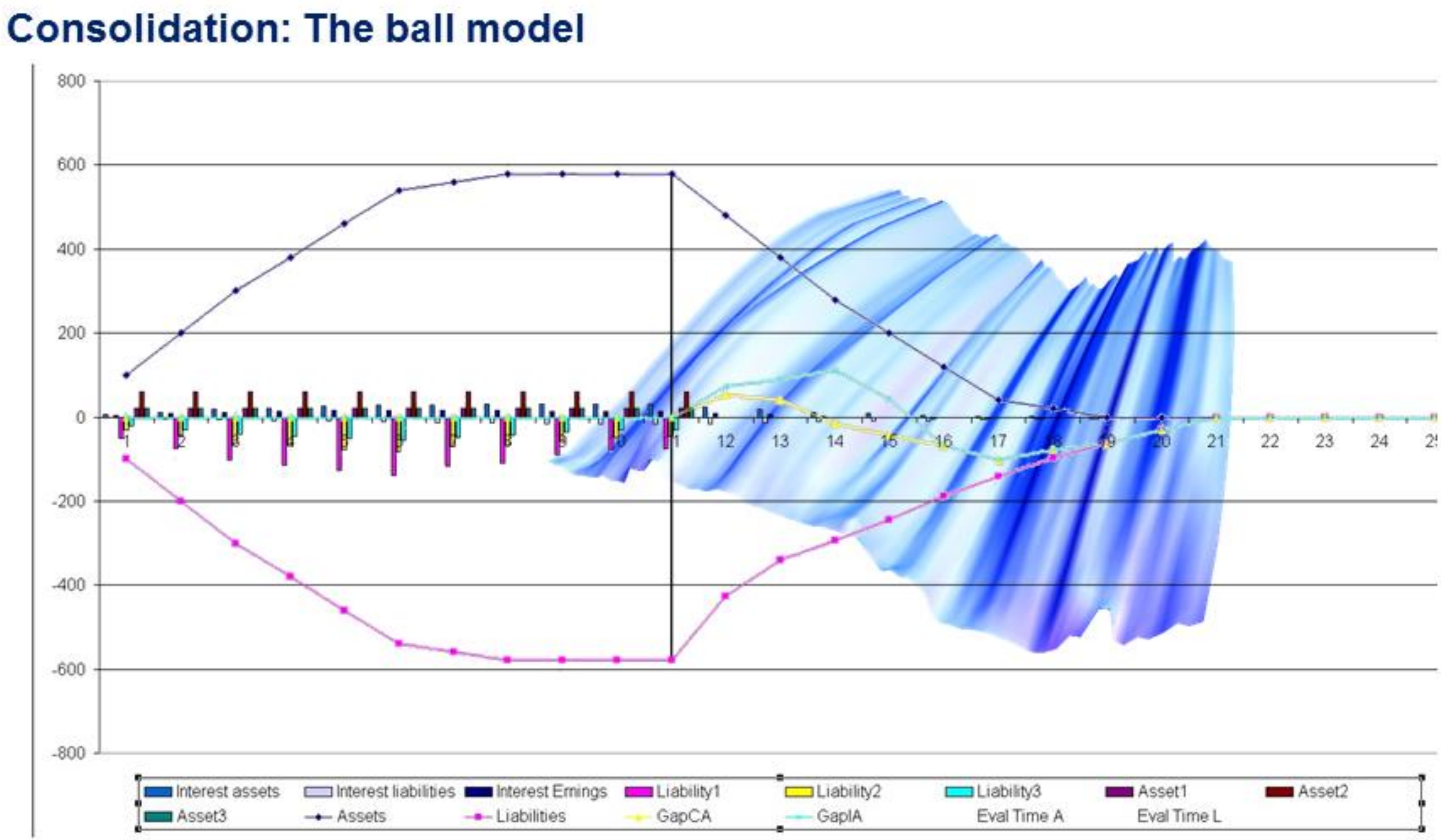
The “bow wave” of the balance sheet



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Cost reduction via canceling “waves”

» How can we achieve an optimal match between business structure, liquidity structure, and interest rate structure while taking into account their dynamics?

Photo source: www.Rudis-Fotoseite.de / pixelio.de

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Cost reduction via canceling “waves”

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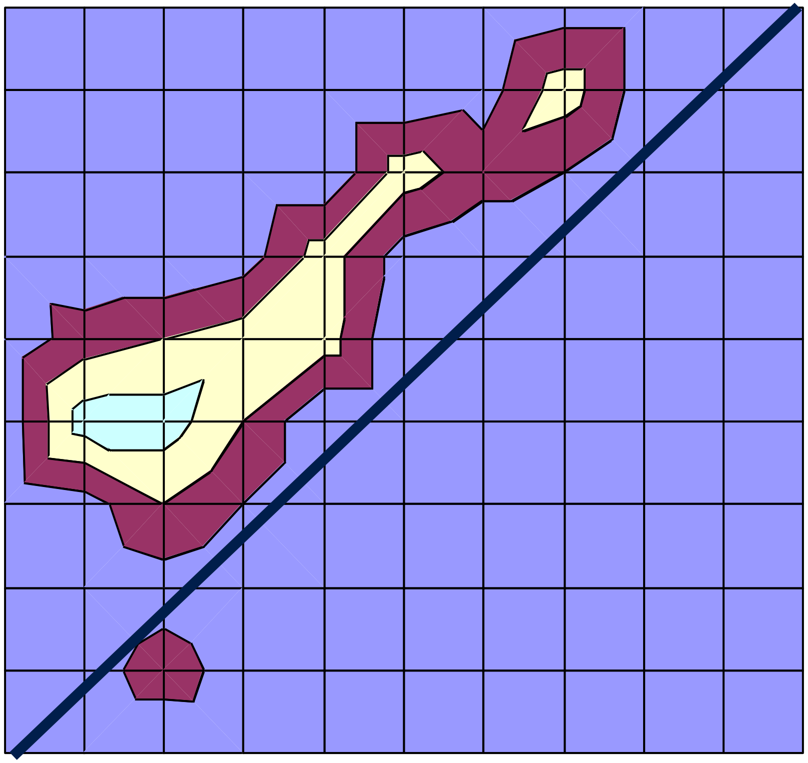
Photo source: FotoHiero / pixelio.de

Cost reduction via canceling "waves"



» How can we achieve an optimal match between business structure, liquidity structure, and interest rate structure while taking into account their dynamics?

Photo source: FotoHiero / pixelio.de

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The costs of the crisis

SoFFin (Sonderfonds Finanzmarktstabilisierung)

Financial Market Stabilization Fund
guarantees of up to 400bn Euros
recapitalize or purchase assets for up to 80bn Euros

Accumulated losses of the SoFFin:

» 2009: 4.3 billion Euros
» 2010: 4.8 billion Euros
» 2011: 13.1 billion Euros
» 2012: 23 billion Euros
» 2013: 21.5 billion Euros

Equity recapitalizations (30.06.2012) :

» Aareal Bank AG: 0.3
» Commerzbank AG: 6.7
» Hypo Real Estate: 9.8
» WestLB AG: 3.0

Source: SoFFin Jahresberichte, http://www.fmsa.de/de/fmsa/soffin/Berichte/index.html

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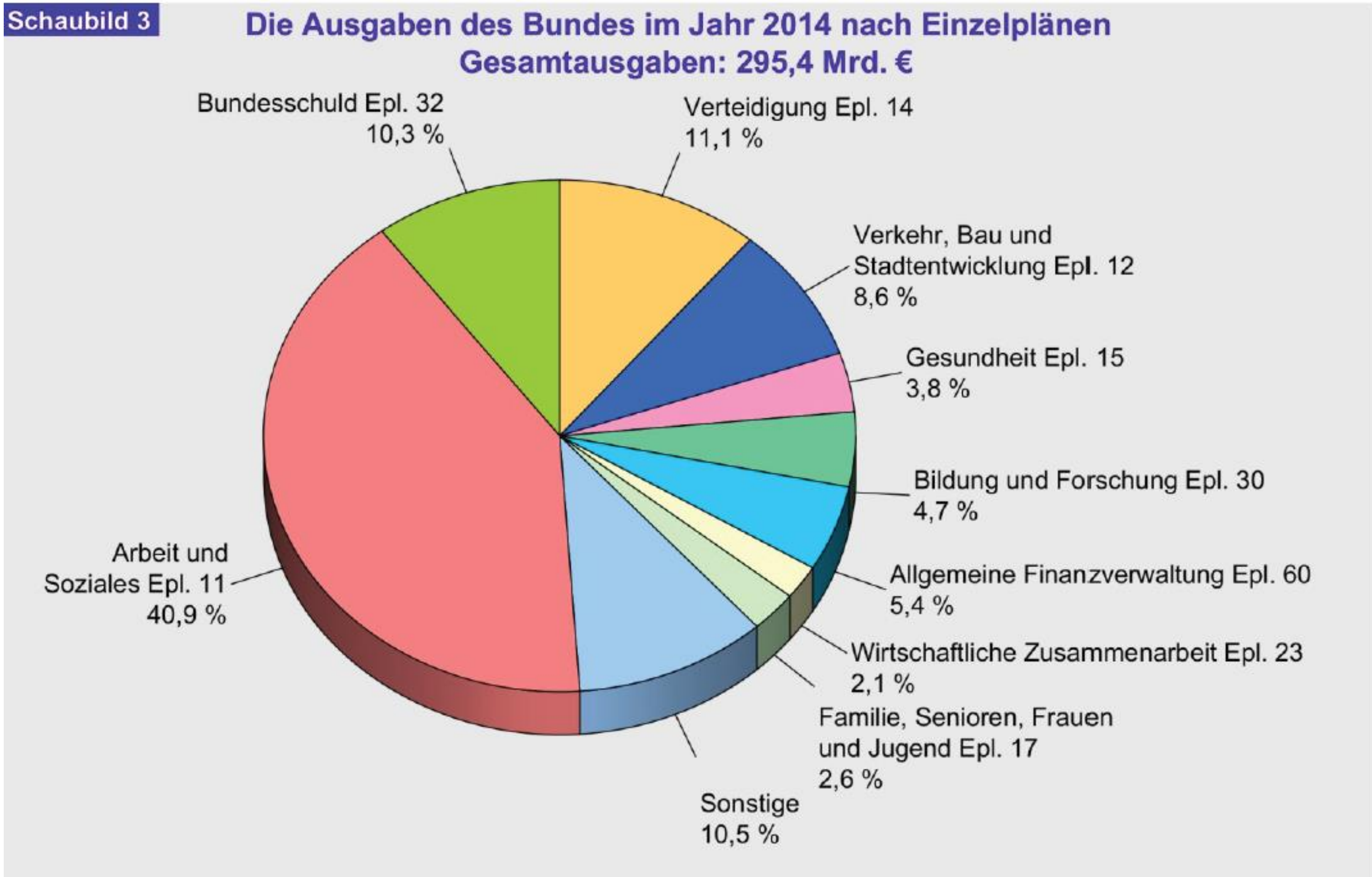
National budget

295 bn EUR in 2014 (estimate)



Source: Bundesministerium für Finanzen, Finanzplan des Bundes 2013-2017, August 2013

Visualizing US debt – 1

100 dollars

Source: Die Welt / August 2011

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Visualizing US debt – 2

10.000 dollars – average years income world wide

Source: Die Welt / August 2011

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Visualizing US debt – 3

1 million dollars

Source: Die Welt / August 2011

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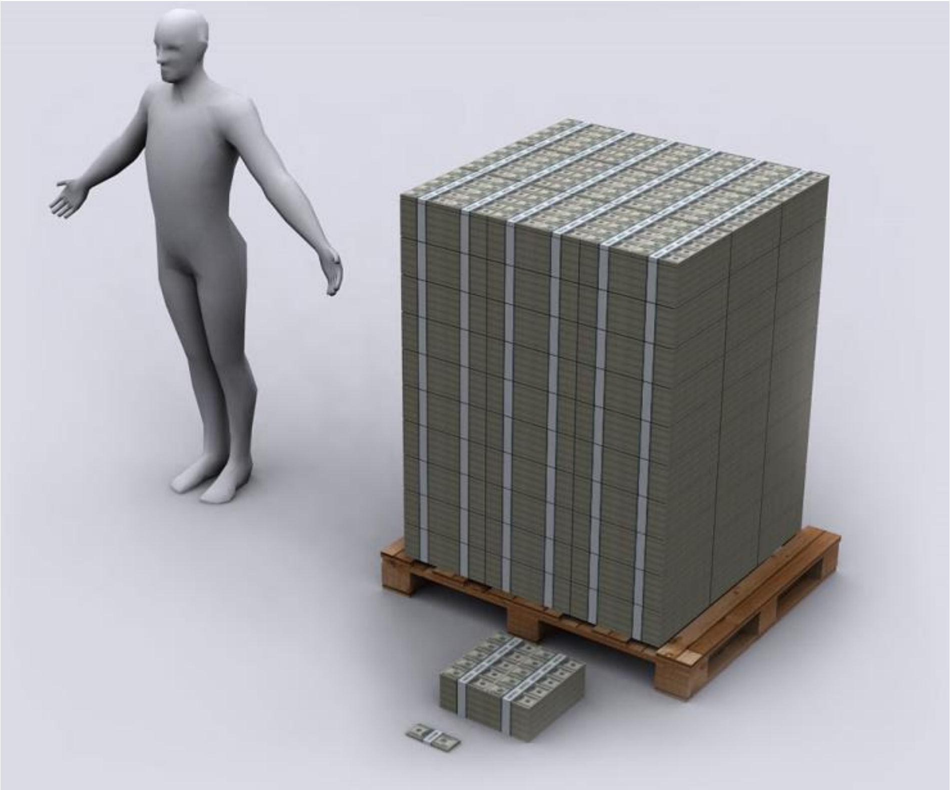
Visualizing US debt – 4



100 million dollars – This amount can be transported on a europallet

Source: Die Welt / August 2011

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Visualizing US debt – 5

1 billion dollars – 10 europallets, not easy to transport

Source: Die Welt / August 2011

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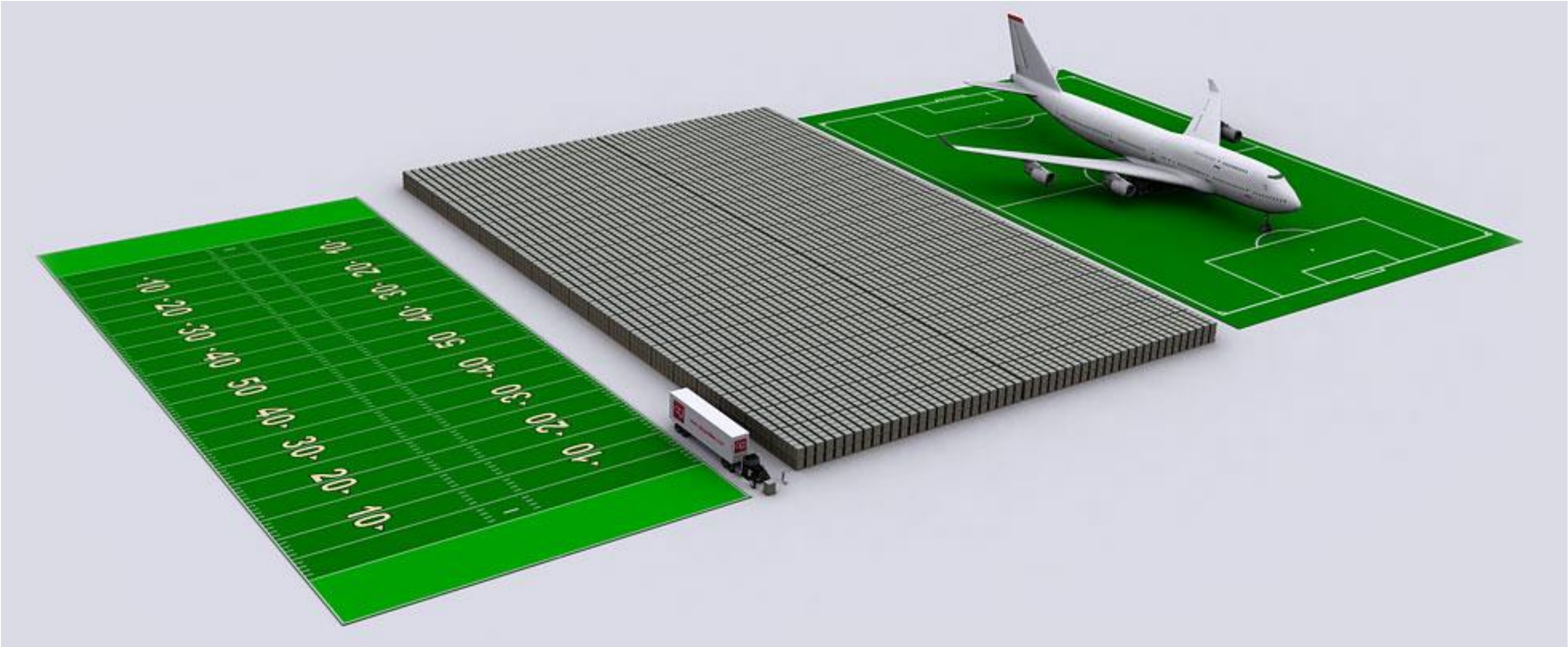
Visualizing US debt – 6



1 trillion dollars – in comparison to an American Football field or a Boeing 747

Source: Die Welt / August 2011

Visualizing US debt – 7

15 trillion dollars – represents the forecasted national debt of the USA at the end of 2011

Source: Die Welt / August 2011

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Visualizing US debt – 8

114,5 trillion dollars –
sum of all unsecured obligations of the USA – i.e. national debt, including pensions, social services and private debt

15 trillion dollars (5 trillion dollars held by foreigners, 1,2 trillion dollars held by China)

Source: Die Welt / August 2011

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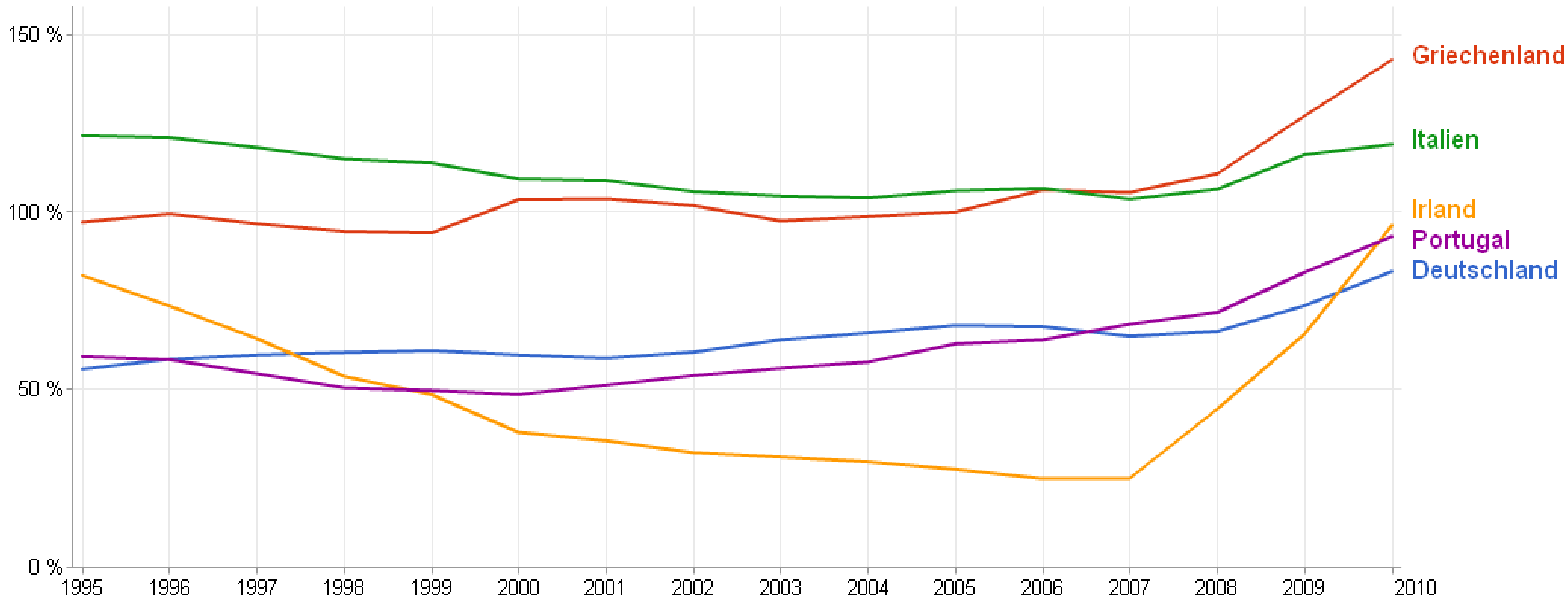
Public debt in percentage of GNP

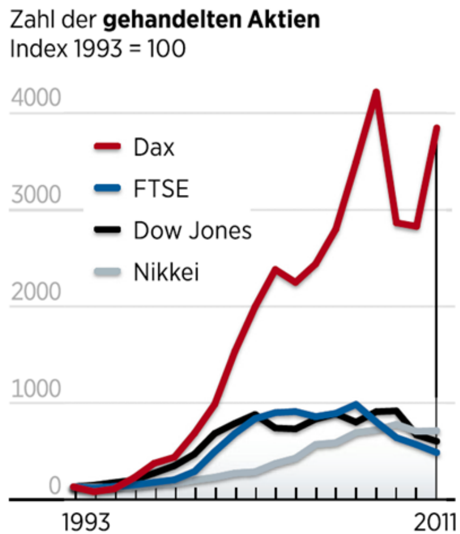


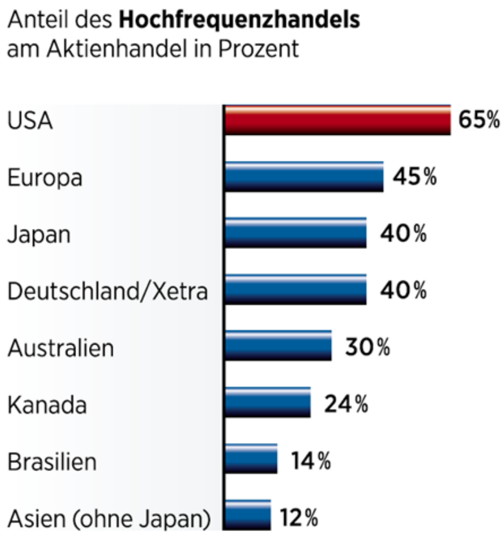
Source: Eurostat, June 2011

Is the financial complexity manageable?

High frequency trading

- » HFT incorporates proprietary trading strategies carried out by computers
- » Electronic exchanges were first authorized by the U.S. Securities and Exchange Commission in 1998
- » Execution times have fallen from several seconds in the year 2000 to milliseconds on modern systems





Source: Handelsblatt 2012

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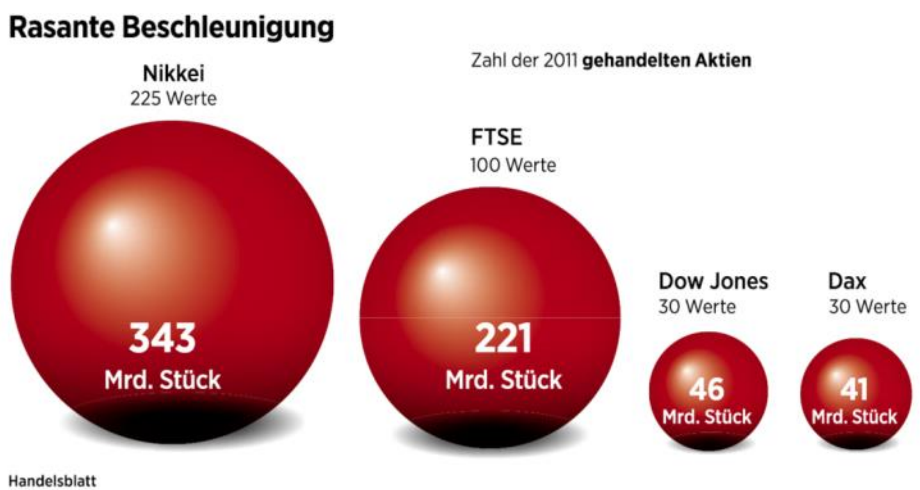
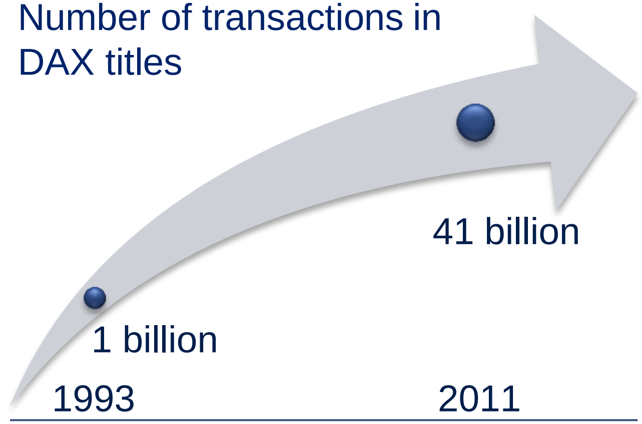
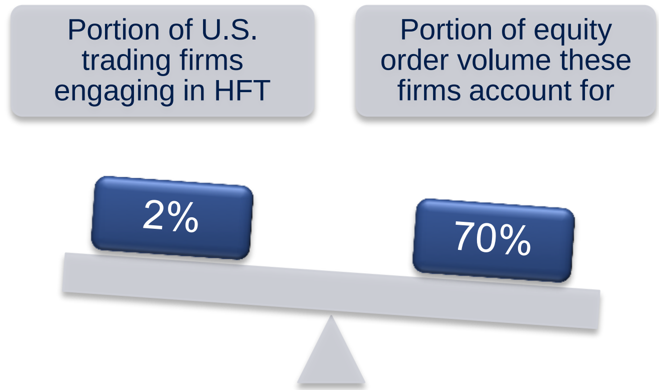
Volume of high frequency trading

- Portion of HFT in U.S. equity trades has increased from less than 10 % in 2000 to over 70% in 2010
- About 40% of Xetra transactions are carried out by HFT systems



Number of transactions in DAX titles





Source: Handelsblatt 2012

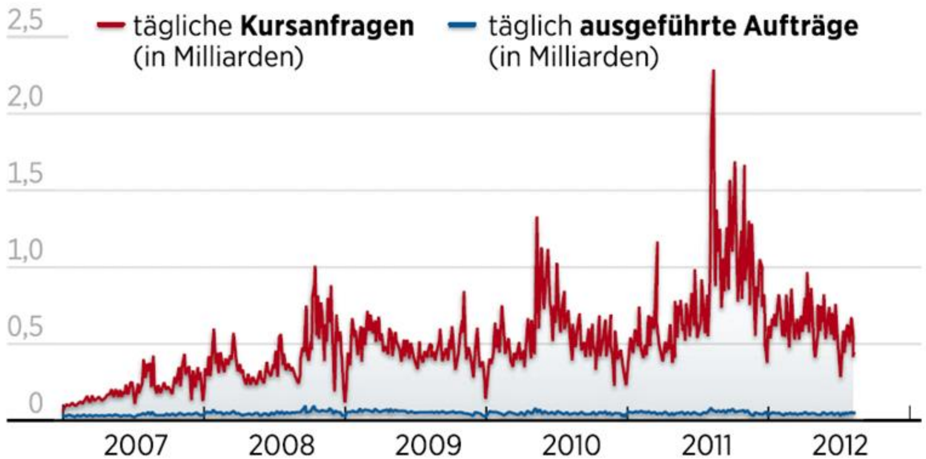
Role of high frequency trading in the crisis

» In 2010 the Dow Jones Index experienced its largest one-day point decline in history ⇨"Flash Crash"

» The U.S. Securities and Exchange Commission and the Commodity Futures Trading Commission concluded in a joint investigation that the actions of HFT firms largely contributed to volatility during the crash.

Der Trick der **Hochfrequenzhändler**

Sie schießen massenweise Aufträge für US-Aktien in die Börsensysteme, ziehen sie dann aber blitzschnell zurück. So suggerieren sie kurstreibende Nachfrage, die aber nicht vorhanden ist. Gehandelt wird nur ein Bruchteil.



Quellen: Bloomberg, Celent, Deutsche Börse, Nanex Research/Wirtschaftswoche

Source: Handelsblatt 2012

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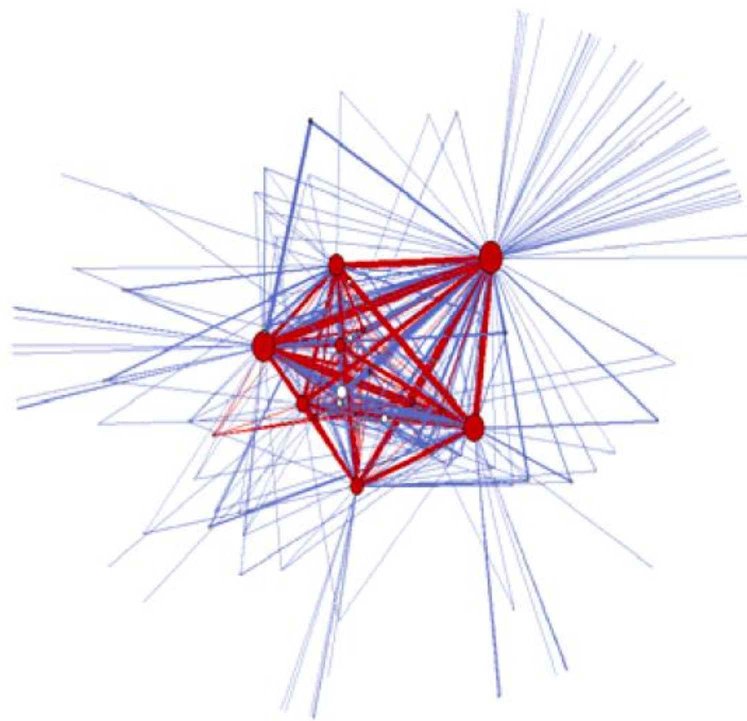
Network topologies of interbank payments

CHAPS: Clearing House Automated Payment System

CHAPS offers same-day sterling fund transfers

Many flows are routed through settlement banks



Source: Becher, Millard, and Soramäki, The network topology of CHAPS Sterling, Bank of England, Working Paper 355

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Network topologies of interbank payments

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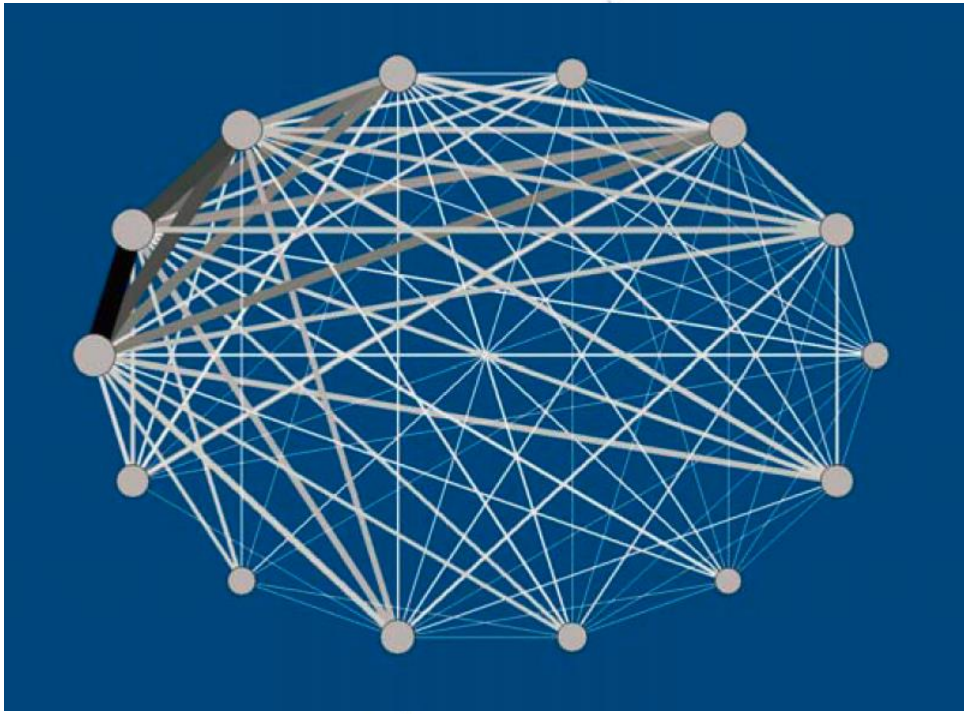

- » The settlement banks form a complete network
- » 4 settlement banks account for almost 80% of the payments, measured by value or volume!

Source: Becher, Millard, and Soramäki, The network topology of CHAPS Sterling, Bank of England, Working Paper 355

Collecting and processing information

Digital economy is founded on data

Photo source: en.wikipedia.org

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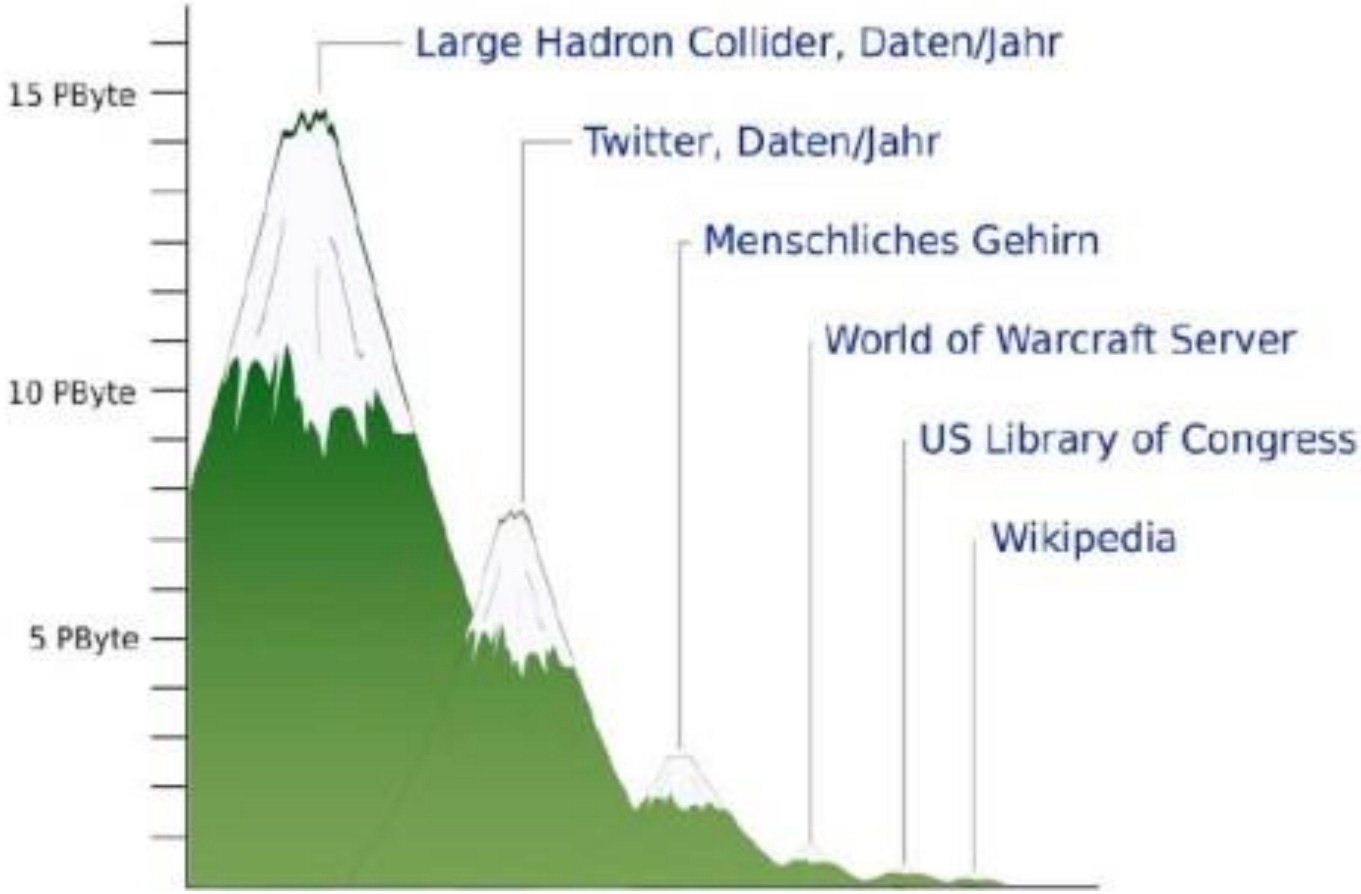
Collecting and processing information



Production of data → “Big Data” → Meaning of data / Value of data

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Watson, we need your help!

Mensch gegen Computer: Bei der populären US-Quizshow „Jeopardy!“ siegte die IBM-Maschine. Jetzt hat sie einen neuen Job

Wall Street heuert „Watson“ an

Super-Computer aus der TV-Quizshow „Jeopardy“ macht jetzt Banker arbeitslos

- Citigroup setzt schlaue IBM-Maschine bereits für Risikoanalysen und zur Kundenberatung ein

Source: WELT KOMPAKT, March 2012

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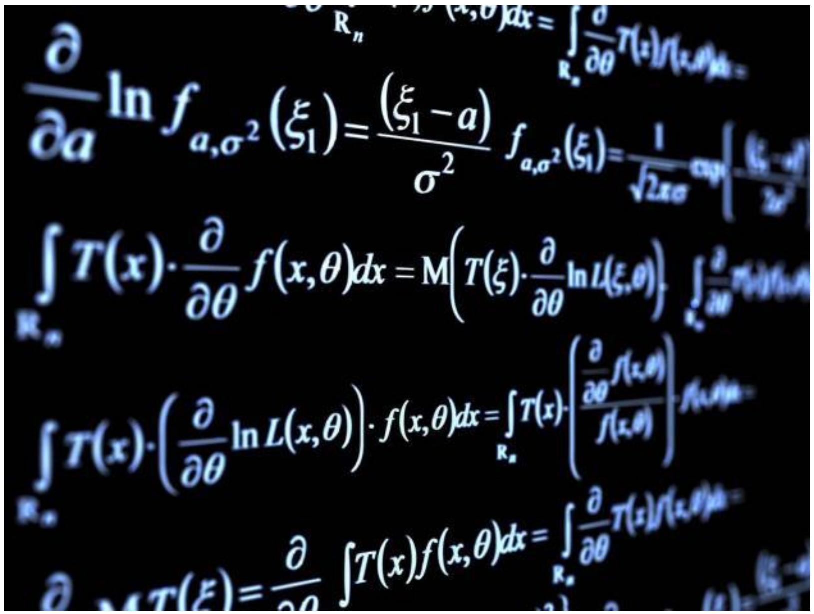
Has physics caused the crisis?



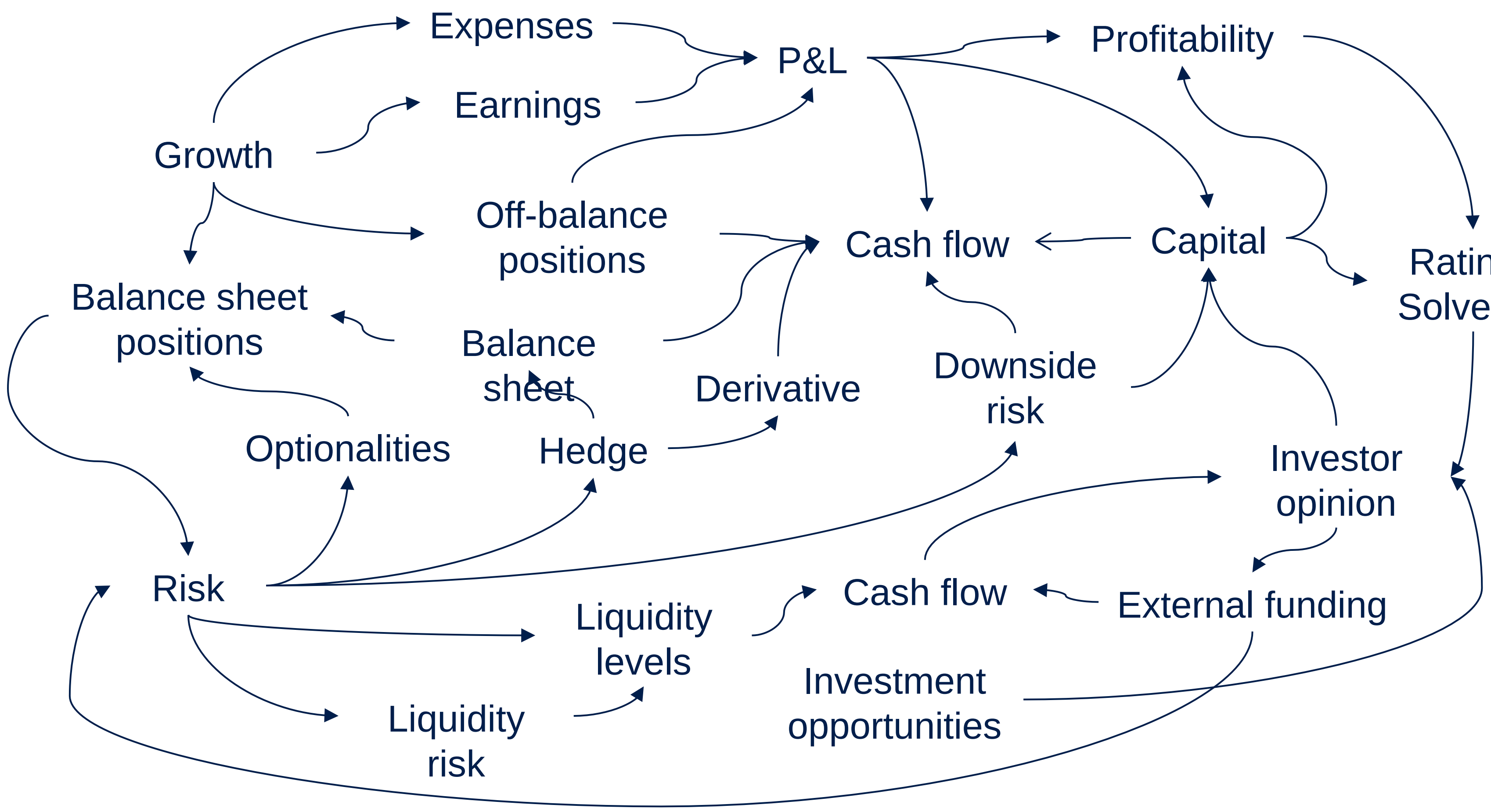
- » Risk management depends heavily on sophisticated models
- » Developed models were too complex to be understood intuitively
- » Computerexperts construct “financial hydrogen bombs” as already suspected by Felix Rohatyn in 1998

Photo source: stock-clip.com

Physical models applied to financial markets

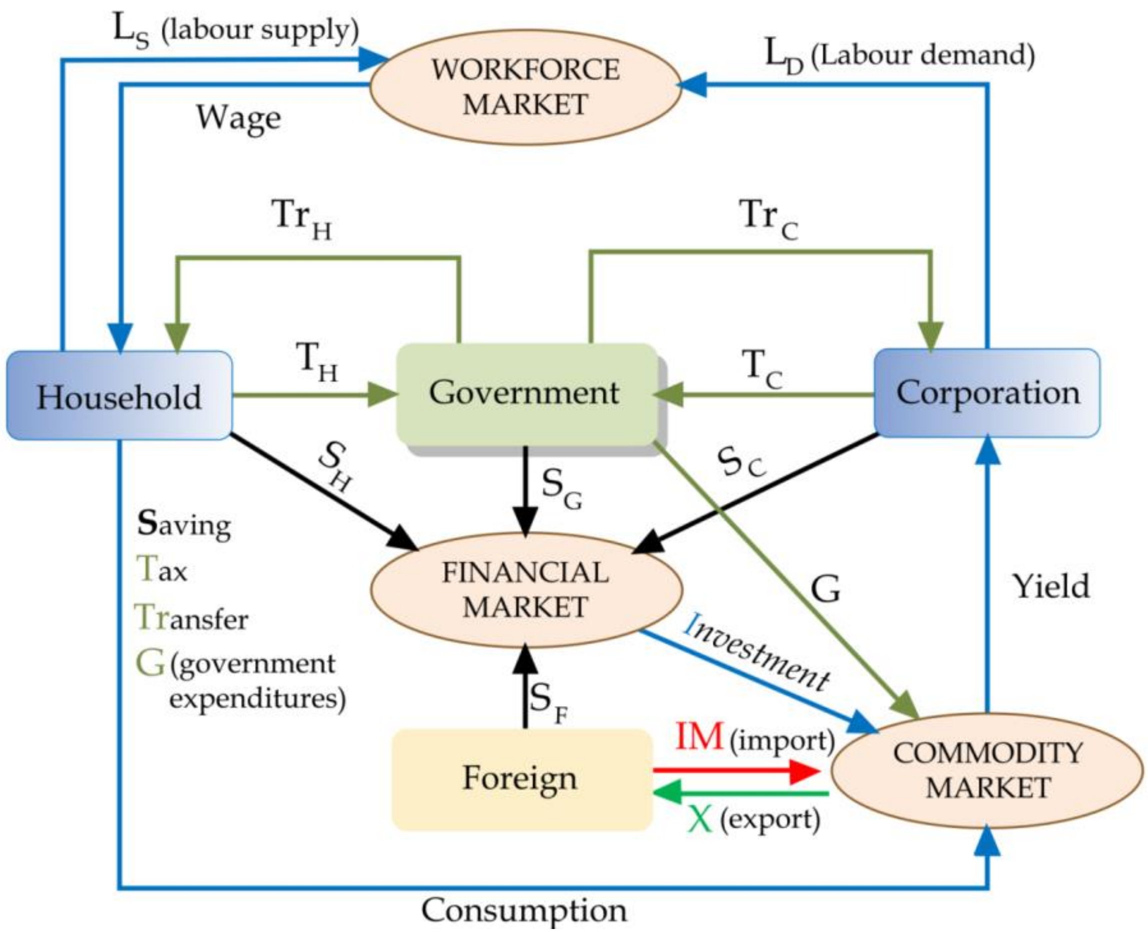
The main problem is: Our models have in fact become extremely complex but are still too simple to be able to incorporate the whole spectrum of variables that drive the global economy. A model is necessarily an abstraction without all details of the real world.

Economics and banking – a complex network of dependencies



From: Managing Liquidity in Banks, R. Duttweiler, 2009

Macroeconomic modelling



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When things fall apart

Vienna, 09.05.1873

New York, 25.10.1929

Northern Rock, 18.9.2007

Photo source: en.wikipedia.org

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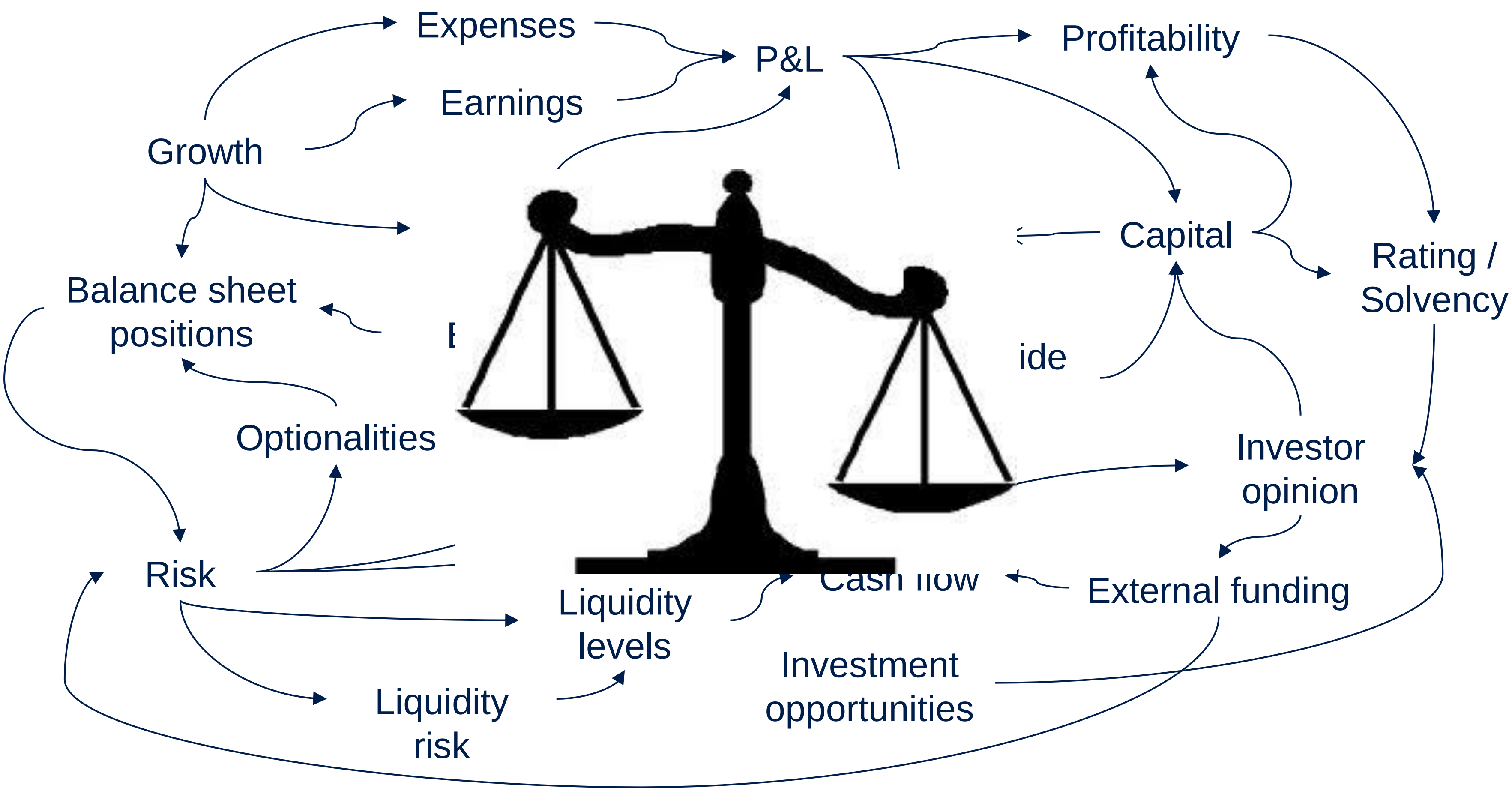
Economics and banking – a complex network of dependencies



From: Managing Liquidity in Banks, R. Duttweiler, 2009

The four "business dimensions"

Business Acumen

Global bank management

Liquidity risk

Greed

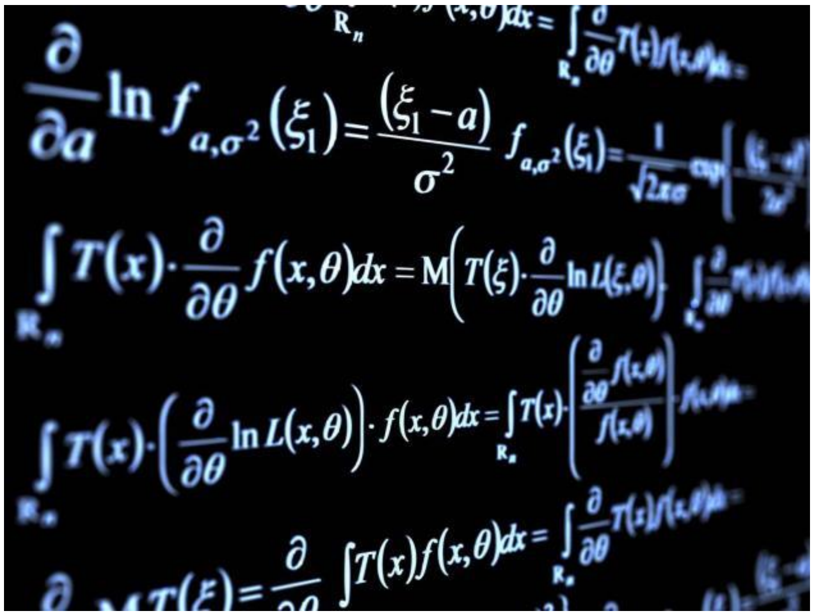
Fear

Modelling

Interest rate risk

Risk
duty of due care

Has physics caused the crisis?



» Risk management depends heavily on sophisticated models

» Developed models were too complex to be understood intuitively

» Computer experts construct “financial hydrogen bombs” as already suspected by Felix Rohatyn in 1998

Ignoramus et ignorabimus.

versus

Wir müssen wissen. Wir werden wissen.

Photo source: stock-clip.com

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