Behind the Scenes of the Swiss Financial Center
The infrastructure and modeling its risks
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Classification: Public
1. The infrastructure of the Swiss financial center

2. Its risks and their quantification
Roughly speaking: what SBB does for people … SIX does for money and securities.

It brings them to their destination, in security.
SIX, backbone of the Swiss financial center

Cash Transactions

- User-owned
- > 3'500 people
- 25 countries
- AA- Rating

Trading & Indices

Financial Data

Handling of Securities
To illustrate things, let us use the help of Mr. Bernoulli

Jakob Bernoulli
A very famous Swiss mathematician from the 17th century, a helper of actuaries and quants
To illustrate things, let us use the help of Mr. Bernoulli
Let us give him an account and a credit card

Card chips are developed by SIX
Mr. Bernoulli using the SIX infrastructure…

- He pays at a store with his card
  - 200’000 terminals
  - 24 transactions per second
- The merchant receives cash from SIX
  - CHF 200m per day
- He withdraws cash from an ATM
  - 10 per second
- Pre-pays his phone, uses a Giftcard, ...
- He pays online with his card (Saferpay)
- Total: 120 card transactions per second
- He sets up e-billing and direct debit
- Cash transactions between banks
  - 20 per second, worth CHF 5m

SIC
Swiss Interbank Clearing
(on behalf of the SNB)
Mr. Bernoulli using the SIX infrastructure…

• He buys shares of the only firm he recognizes from the 17th century…
  ► Orell Füssli (1519, also money printers)

• He also buys some ETF’s, Bonds and collateralized structured products
  ► 5 transactions per second
  ► Daily: CHF 4b and 220 new listings
  ► 40’000 securities listed
  ► Large offer of indices, such as SMI

• His bank and insurer obtain liquidity from the SNB using repurchase agreements (Repo)
  ► Outstanding CHF 70b during 2008 crisis

• The data is distributed to the world

• Cash is transferred between banks

• Securities are transferred between banks
Mr. Bernoulli using the SIX infrastructure…

• He reads the financial data and news:

  ▶ Data on 7 million financial instruments:
    a) Reference data
    b) Market data (prices, indices, etc.)
    c) News and analyses

  ▶ 30’000 price telegrams per second

  ▶ 850 data sources (e.g. exchanges)
Mr. Bernoulli using the SIX infrastructure …

- The securities he bought are **cleared** at once
  - SIX is the central counterparty
  - 15 transactions per second
- … and **settled three days later**
  - SIX transfers cash and securities
  - 2 transactions per second
- He receives **dividends from his shares** and **coupons from his bonds**
  - 1’500 corporate actions daily
- He decides to **short-sell some shares**
  - Securities lending & borrowing
- His shares are registered
  - He is invited for general meetings
- His assets are (electronically) kept in a **safe**
  - CHF 2,5 trillion assets
  - 800 tons of gold & silver worth CHF 10b

“The Swiss Fort Knox”

Handling of Securities
The safe seen from the inside…
The safe seen from the inside (really)
Quiz: what are the risks?

Sample of answers:

- **X** “There are no risks“  
  Frequent answer, but wrong

- **X** “There are risks, and the largest is called Basel III”  
  Sorry, you sound like a bad head of risk management at a bank

- **✓** “There are many risks. They create jobs for risks controllers and actuaries”  
  Actually right!
What are the risks?
In “Cash Transactions”

• **IT-system breaks and most people cannot make card payments**
  ▶ Yes, it happens. Most (in)famous event: 24.12.2001…

• **System is hacked and card information is stolen**
  ▶ Never happened before at SIX. It has happened in other companies.

• **A large online merchant defaults**
  ▶ SIX can be held responsible for delivering paid products not yet delivered…

• **The interbank payment system does not work**
  ▶ There are strict requirements from the SNB, including contingency plans.
What are the risks?
In “Trading and Indices”

• The stock exchange does not function
  ► It happens. Banks can use other exchange platforms in the meantime.

• A mistake is done during an IPO
  ► Remember Facebook? UBS does.

• An index is wrongly calculated
  ► Potential consequences can be big.

• Self-regulation is compromised
  ► Large reputational effect.
What are the risks?
In “Financial Data”

- The world is split in half between Bloomberg and Thomson-Reuters
  - Something like this happened in 1494 with the “Treaty of Tordesillas”
What are the risks?
In “Handling Securities”

- **IT-system breaks and transactions are not possible**
  - There are strict requirements from the SNB, including contingency plans.

- **A settlement member defaults**
  - If there are outstanding cash positions (credit), then it is nice to have good collaterals to cover them.

- **A clearing member defaults**
  - Risk mutualization: the importance of properly computing margin requirements and default fund contributions…

- **A mistake is make in executing a corporate action**
  - Correcting the mistake can result in a loss, or a profit.
How (not) to analyze risks?

Afghanistan war: social, political and economical risks

“When we understand that slide, we’ll have won the war”

Gen. Stanley McChrystal, US and NATO force commander
How to analyze risks?

• **Quantification is very useful** – it allows to:
  ▶ Understand better the risk and what the main factors are
  ▶ Track the effect of changes in the business environment
  ▶ Compare and aggregate risks
  ▶ Estimate the required capital, as well as allocate it
“Actuarial” Model
Example: Loss Distribution Approach (LDA)

- It needs historical data
  - E.g. insurance claims
- Copula aggregation can be quite non-intuitive
- No direct link with the business environment
  - Credit spreads, processes, etc. are not visible
“Process Based” Model
Example: Causal Model

- **Driving factor must be identified and calibrated**
  - For instance: default probability from credit spreads

- **Provides a natural frame to introduce correlations**
  - Use common factors. Examples: a market, or default of the same bank across various risks

- **Direct link with the business environment**
  - For instance: improving a process might decrease exposure
### Example: Counterparty risk

#### Risk 1 – Liquidity Management in Settlement

<table>
<thead>
<tr>
<th>Processes and Threats</th>
<th>Variables (example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banks have collateralized lines</td>
<td>$a_i = \text{Limits (CHF 10 million)}$</td>
</tr>
<tr>
<td>The banks use their lines</td>
<td>$U_i = \text{Uniform variable (0-100%)}$</td>
</tr>
<tr>
<td>A bank defaults</td>
<td>$B_i = \text{Bernoulli variable (p=2%, from CDS)}$</td>
</tr>
<tr>
<td>Collaterals are sold in market</td>
<td>$M_i = \text{Gaussian variable (μ=0%, σ=5%)}$</td>
</tr>
</tbody>
</table>

**Loss** = \( \sum_{i=1}^{N} a_i \times U_i \times B_i \times M_i \) (if \( M < 0 \))

#### Risk 2 – Liquidity Management in Treasury

<table>
<thead>
<tr>
<th>Processes and Threats</th>
<th>Variables (example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasury has various bank accounts</td>
<td>$b_j = \text{Limit (CHF 10 million)}$</td>
</tr>
<tr>
<td>The treasurer deposits cash in accounts</td>
<td>$D_j = \text{Triangular variable (CHF 0-7-10 million)}$</td>
</tr>
<tr>
<td>A bank defaults</td>
<td>$B_j = \text{Bernoulli variable (p=2%, from CDS)}$</td>
</tr>
<tr>
<td>Recovery after liquidation</td>
<td>$R_j = \text{Recovery rate (0%)}$</td>
</tr>
</tbody>
</table>

**Loss** = \( \sum_{j=1}^{M} b_j \times D_j \times B_j \times (R_j - 1) \)

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Correlation between defaults

Reviewed by [PRS Logo]
Example: Counterparty risk

Risk 1 – Liquidity Management in Settlement

A bank defaults → Common factors (banks) → Correlation between risks

Risk 2 – Liquidity Management in Treasury

A bank defaults
Example: Operational risk

- **Mistakes from corporate actions**
  - There is historic data (a requirement from the regulators)

- **Processes are well understood, including some risky ones**
  - Usage of external data
  - Manual operations
  - Time pressure
Example: Operational risk
Corporate Actions team in action…
### Example: Operational risk

**Risk 3 – Operational Mistakes in Corporate Actions**

<table>
<thead>
<tr>
<th>Processes and Threats:</th>
<th>Variables (example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of a corporate action</td>
<td>$A_i = \text{Log-normal variable}$ ($m=10$, $s=3$)</td>
</tr>
<tr>
<td>Yearly mistake frequency</td>
<td>$N = \text{Poisson variable}$ ($\lambda=10$)</td>
</tr>
<tr>
<td>Relative size of a mistake</td>
<td>$S_i = \text{Uniform variable}$ ($a=0$, $b=7%$)</td>
</tr>
<tr>
<td>Instruments are sold/bought</td>
<td>$M_i = \text{Gaussian variable}$ ($\mu=0%$, $\sigma=5%$)</td>
</tr>
</tbody>
</table>

**Loss (or profit) =**

$$\sum_{i=1}^{N} A_i \times S_i \times M_i$$

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**CDF**

- **Model Result**
- **Historical Data**

**Truncation** (log scale)

**Individual Loss Amount**
Thank you for your attention.

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