TECHNISCHE UNIVERSITÄT WIEN

The OntoREA© Accounting and Finance Model

A Retroactive DSRM Demonstration and Evaluation

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Motivation: A simple Forward case study

- Imagine you are a fruit shop owner
  and a client orders 100 kilos of Chiquita bananas
  to be delivered at Grote Markt 9 at the upcoming new year's eve.
- What is the price per kilo that you have to ask for to be paid by the client at delivery date?

https://upload.wikimedia.org/wikipedia/commons/thumb/c/c8/Spider-Firework-Omiya-Japan.jpg/220px-Spider-Firework-Omiya-Japan.jpg

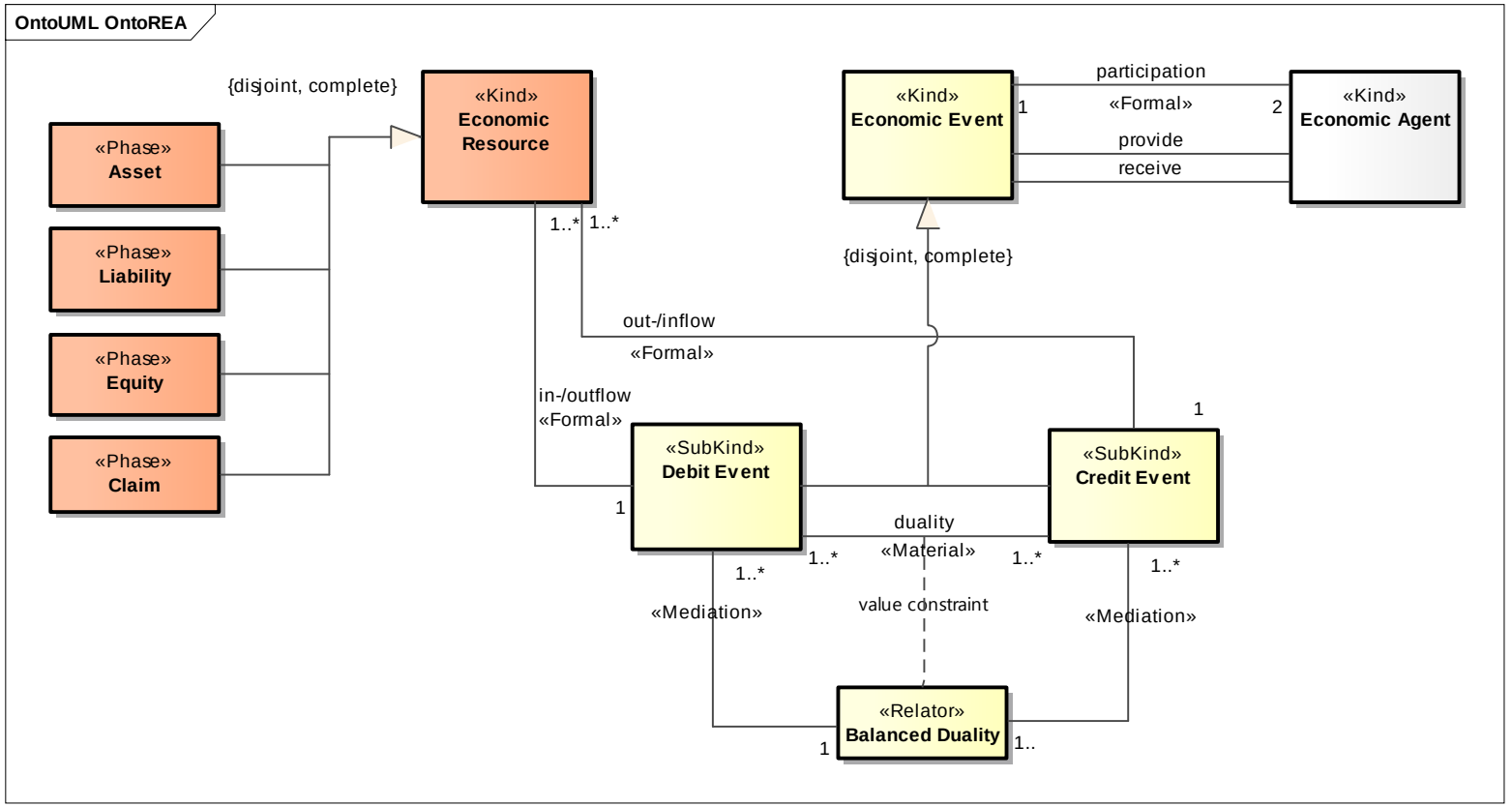
https://sc01.alicdn.com/kf/HTB1AoQbKVXXXXaWXpXXq6xXFXXXW/Printing-banana-carton-box.jpg_350x350.jpg

https://upload.wikimedia.org/wikipedia/commons/thumb/5/57/Leuven_City_Hall%2C_looking_up_from_base_at_night.jpg/220px-Leuven_City_Hall%2C_looking_up_from_base_at_night.jpg

Introduction

- Problem: Missing demonstration and evaluation of the OntoREA© Accounting and Finance Model
- Design Science Research Methodology
  - Demonstration via real-case:
    - Stock forward contract example
  - Evaluation via adequate representation of derivative instruments:
    - Mapping of hedging portfolio approach
    - Consideration of Asset/Liability/Off Balance phases of forward contracts
- Model-driven Development context
  - From Platform Independent to Platform Specific Model
  - From Platform Specific to Implementation Specific Model
  - Prototypical application in RStudio/Shiny
- Conclusion

From OntoREA to OntoREAC ACC and FIN Model



- OntoREA Accounting and Finance Model in OntoUML
  - Rigid REA-backbone:
  - Resource, Event, Agent as <<Kind>> stereotype
  - Balanced Duality as <<Relator>> stereotype
  - Anti-rigid Economic Resources as <<Phase>> stereotype

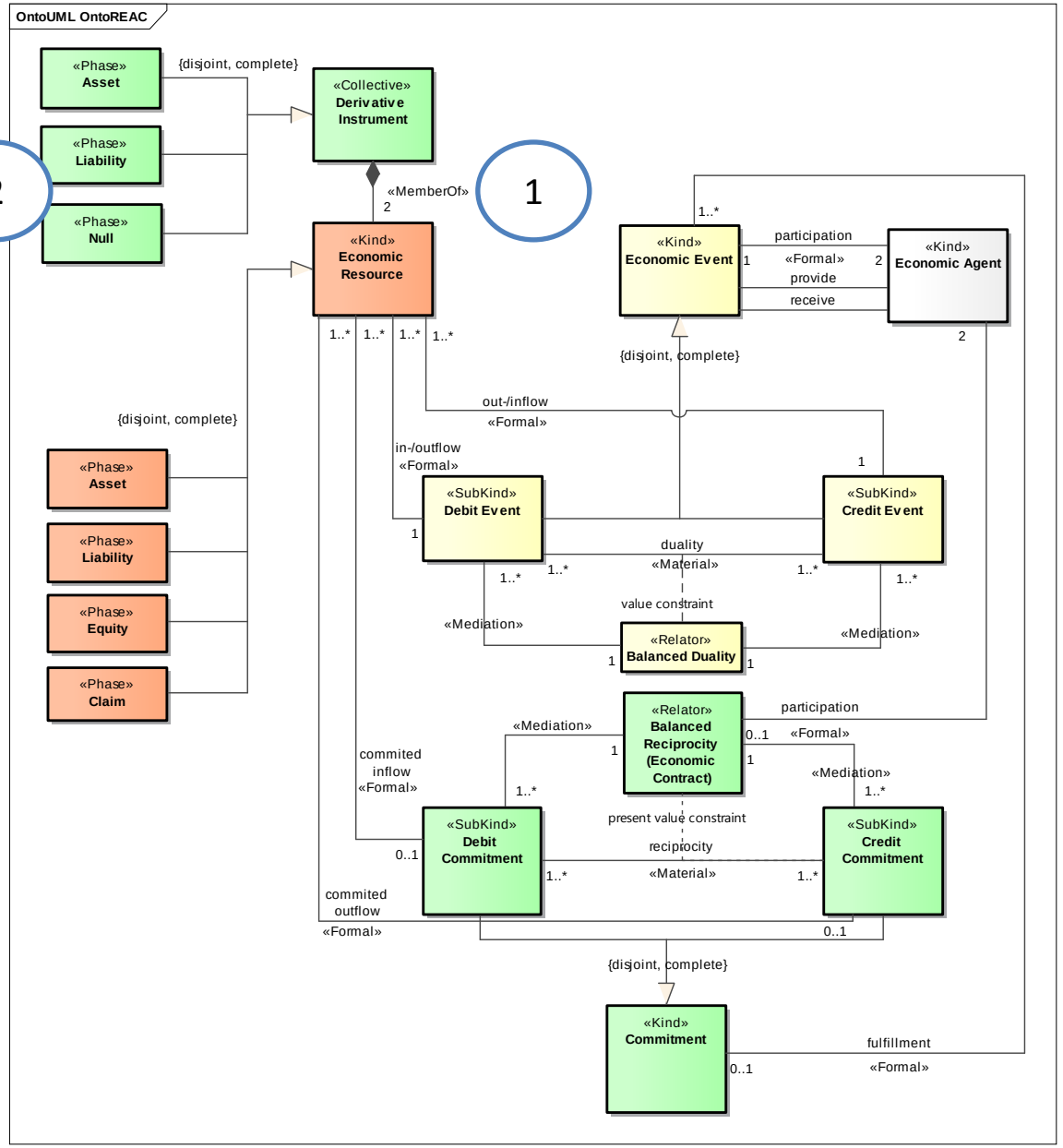
Fischer-Pauzenberger, C., Schwaiger, W.S.A.: The OntoREA Accounting Model: Ontology-based Modeling of the Accounting Domain. Complex Syst. Informatics Model. Q. (2017)

Derivative instruments: Definition and no-arbitrage

- Peculiarities of derivative instruments: Replication via hedging portfolio

Derivative peculiarities	Modeling in OntoUML
1 Hedging portfolio of derivative	<<Collective>> Derivative Instrument with <<MemberOf>> relationship
1a) Long leg (Asset)	<<Kind>> Economic Resource/Asset
1b) Short leg (Liability)	<<Kind>> Economic Resource/Liability
2 Balanced reciprocity constraint	<<Relator>> Economic Contract
Fair Value = Sum (Long, Short leg)	
3. Modal-temporal behaviour (balance sheet recognition)	<<Phase>> Asset/Liability/Off Balance

From OntoREA to OntoREAC ACC and FIN Model

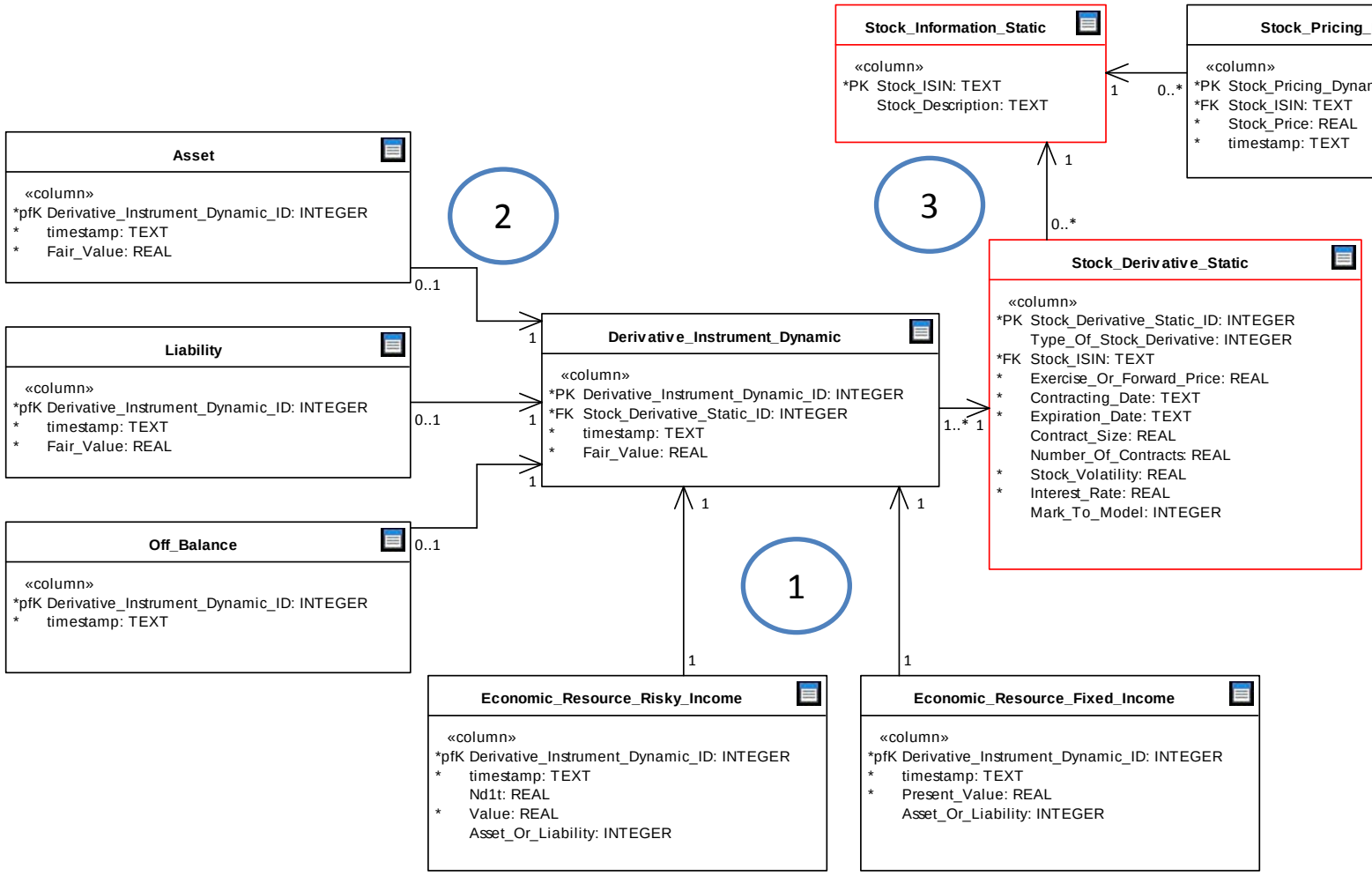


- Setting the OntoUML model of derivative instruments upon the **OntoREA Accounting Model**, gives the
- OntoREA© Accounting and Finance Model
  1. Mapping of hedging portfolio as <<Collective>> stereotyped entity
  2. Considering the modal-temporal behaviour of derivative instruments via the <<Phase>> stereotyped entities Asset, Liability and Off Balance
- Using the model as Platform Independent Model

Derivative instruments: Definition and no-arbitrage

Contracting date:	01.01.2020
Expiration date:	31.12.2020
Initial stock price:	100
Initial interest rate:	4%
Long leg: Stock Asset	100
Short leg: Loan Liability	100
Forward value: = A - L	**0 (Off B.)**
Pricing date #1:	30.06.2020
Actual stock price:	100
Actual time to maturity:	6 months
Stock Asset:	100
Loan Liability:	101,98
Forward value: = A - L	**-1,98 (L)**
Pricing date #2:	31.12.2020
Actual stock price:	120
Actual time to maturity:	0 months
Stock Asset:	120
Loan Liability:	104
Forward value: = A - L	**16 (A)**

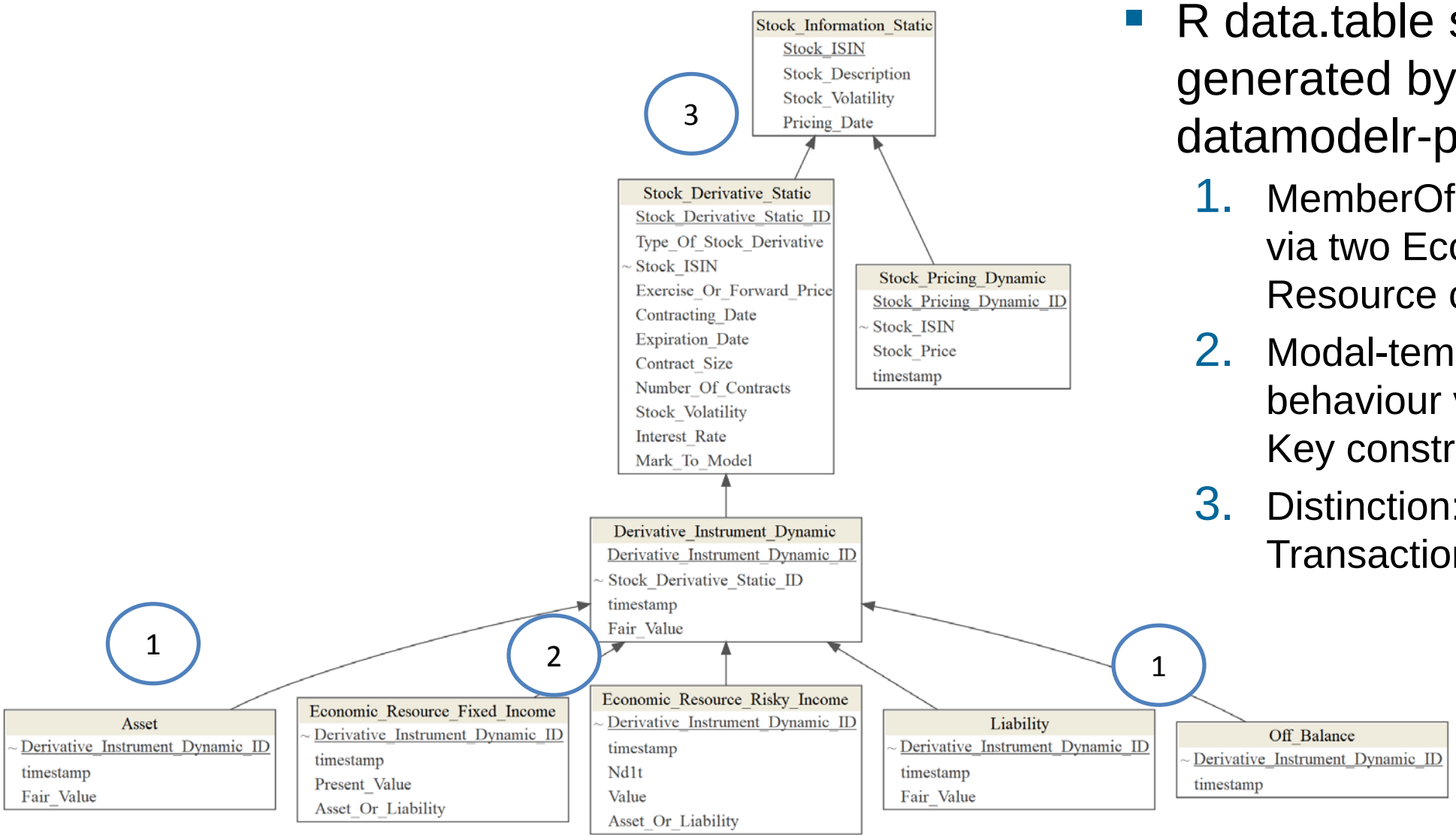
MDD: From Platform Indep. to Platform Spec. Model



- Transforming UML class diagrams into relational data models
  1. MemberOf-Relation via two Economic Resource classes
  2. Modal-temporal behaviour via Foreign Key constraint
  3. Distinction: Master-Transactional Data

Slaughter, Sandra. "Transforming UML class diagrams into relational data models." *UML and the Unified Process* (2003): 217.

MDD: From Platf. Spec. to Implement. Spec. Model



- R data.table structure generated by R datamodelr-package
  1. MemberOf-Relation via two Economic Resource classes
  2. Modal-temporal behaviour via Foreign Key constraint
  3. Distinction: Master-Transactional Data

MDD: From Platf. Spec. to Implement. Spec. Model

Generalization set constraint: Modeling modal-temporal behaviour of derivative instruments as

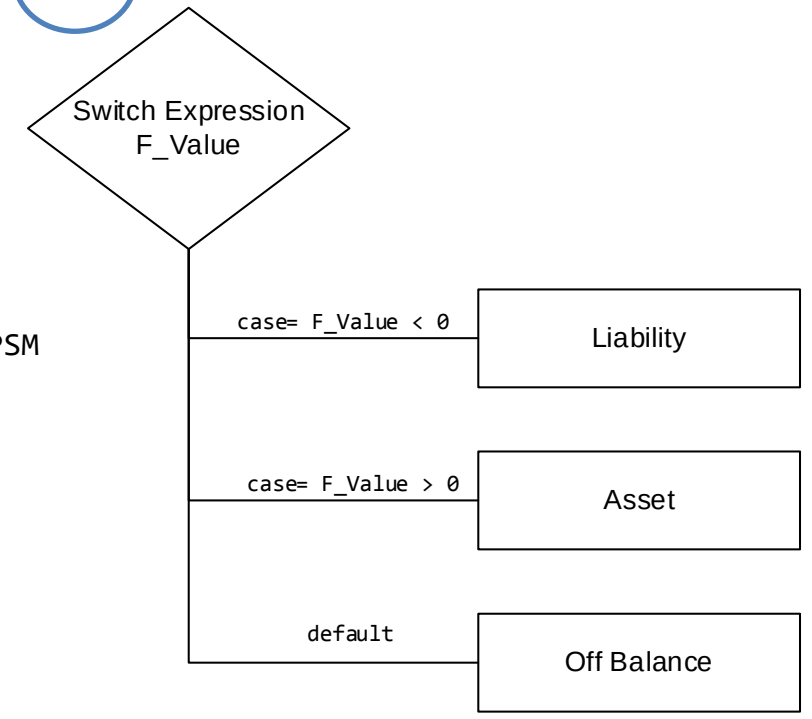
A) OCL constraint (PSM)
B) switch expression (ISM)

A

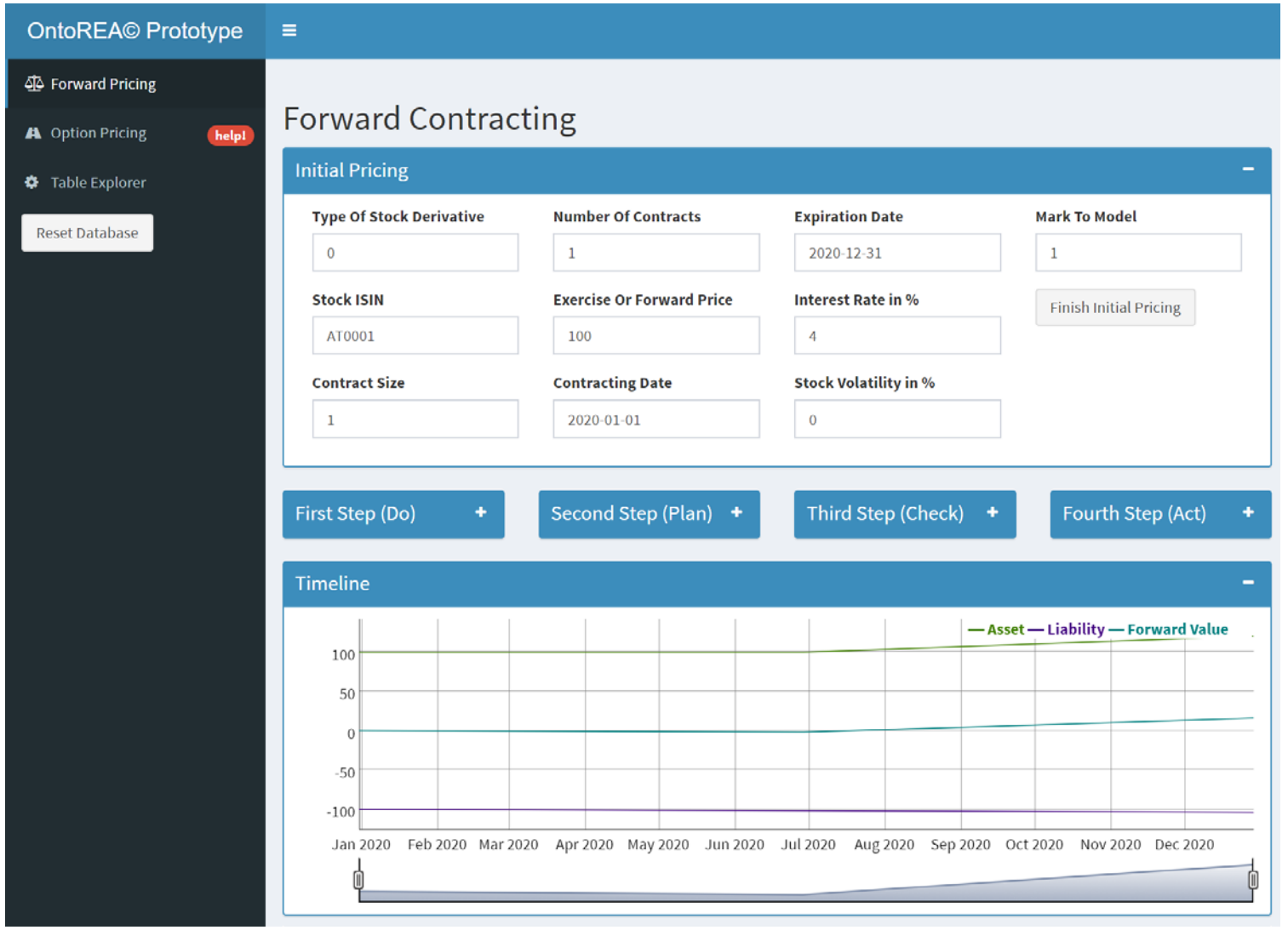
```
Algorithm. OCL invariant for the exclusivity of derivative instrument phases in PSM

context d: Derivative_Instrument inv exclusivePhaseReferences :
def : assetExists : Boolean =
       Asset.allInstances()->exist (a|a.Derivative_ID = d.Derivative_ID)
def : liabilityExists : Boolean =
       Liability.allInstances()->exist (l|l.Derivative_ID _d = d.Derivative_ID)
def : offbalanceExists : Boolean =
       Off_Balance.allInstances()->exist (o|o.Derivative_ID _d = d.Derivative_ID)
(assetExists xor liabilityExists) xor offbalanceExists
```

B



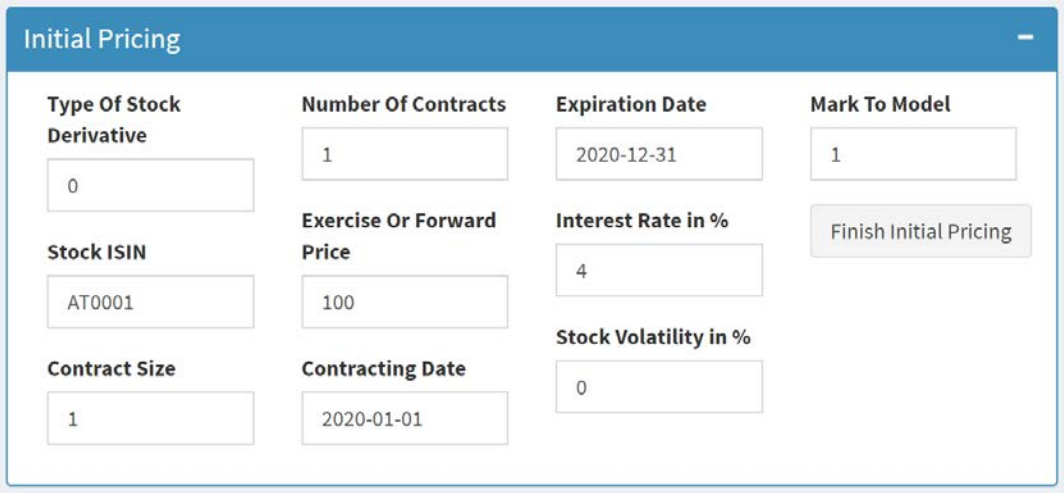
MDD: RStudio/Shiny application



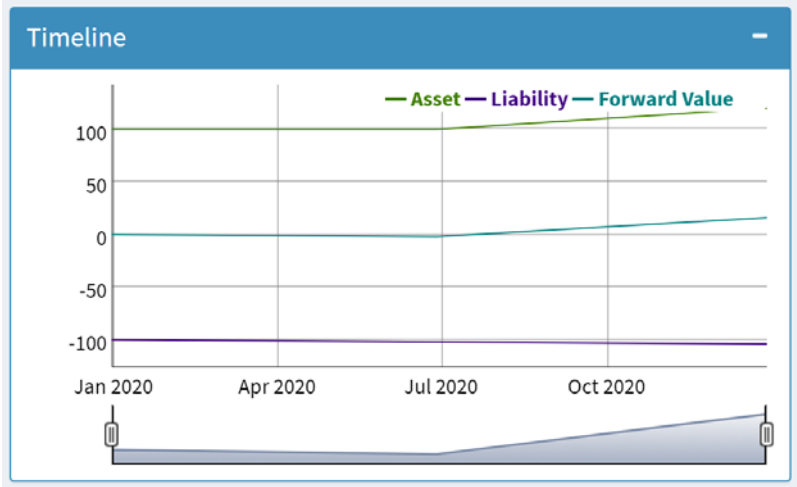
MDD: RStudio/Shiny application

Timestamp	Risky Asset Value	Fixed Asset Value	Forward Fair Value	Phase
2020-01-01	100	-100	0	Off Balance
2020-06-30	100	-101.98	-1.98	Liability
2020-12-31	120	-104	16	Asset

Input: contract specification data



Output: Forward value over time



Conclusion and outlook/future research

- Conclusion
  - Demonstration via real-case: Stock forward contract example
  - Evaluation via adequate representation of derivative instruments
    - Mapping of hedging portfolio as <<Collective>> stereotyped class with MemberOf-relationship to Economic Resources
    - Including temporal-modal behaviour of forward contracts with <<Phase>> stereotyped classes (Asset, Liability and Off Balance)
- Further research
  - Option pricing: Inclusion of dynamic adjustments of the hedging portfolio
  - Including an explicit hedging specification at policy level in REA business ontology (Geerts and McCarthy, 2006)