Financial markets dependence modeling using vine copulae

Preliminary work for vine copula modeling in finance

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Vine copulas and their Applications
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Context of the project

- Luxembourgish fund industry is a leading industry in Europe with EUR 4,280 Bn net assets[1]and the total european fund industry represents EUR 16,032 Bn[1].
- The project is supported by the private sector for investment fund net asset validation.

[1]EFAMA Quarterly Statistical Release Q3 2018

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Dependence measures for copula modeling

Different dependent measures appear in the literature:

- Concordance measures (Schweizer & Wolff, 1981)
- Dissimilarity or distance measures (Berndt & Clifford, 1994)
- Other non linear measures (Székely et al, 2007), (Lopez-Paz et al, 2013), (Reshef et al 2011)
- Financial performance or benchmarking measures (Sharpe, 1966), (Keating & Shadwick, 2002), (Cogneau & Hubner, 2009)

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Sequential approach based on weights

The sequential approach based on weights relies on minimization of weights to select the ideal structure of the tree. Minimum spanning tree algorithm:

$$T_1 = \text{argmin}_{T=\{N,E\}SP} \sum_{e \in E} \omega_{i(e),j(e)}, \tag{1}$$

where

$$\omega_{i(e),j(e)} = TE_{i(e),j(e)} = \sqrt{\frac{1}{N-1} \sum_{k=1}^{n} (x_{i(e),k} - x_{j(e),k})^2}$$

are the weights associated to the variable pairs (i, j).

Tracking error as basis for the minimum spanning tree

Advantages of using tracking error for the MST algorithm:

- It is equivalent to the Euclidean distance.
- It is not a monotonic dependence measure.
- It is already used in the finance literature for benchmark replication.

The MST gives very intuitive results for portfolio risks decomposition.

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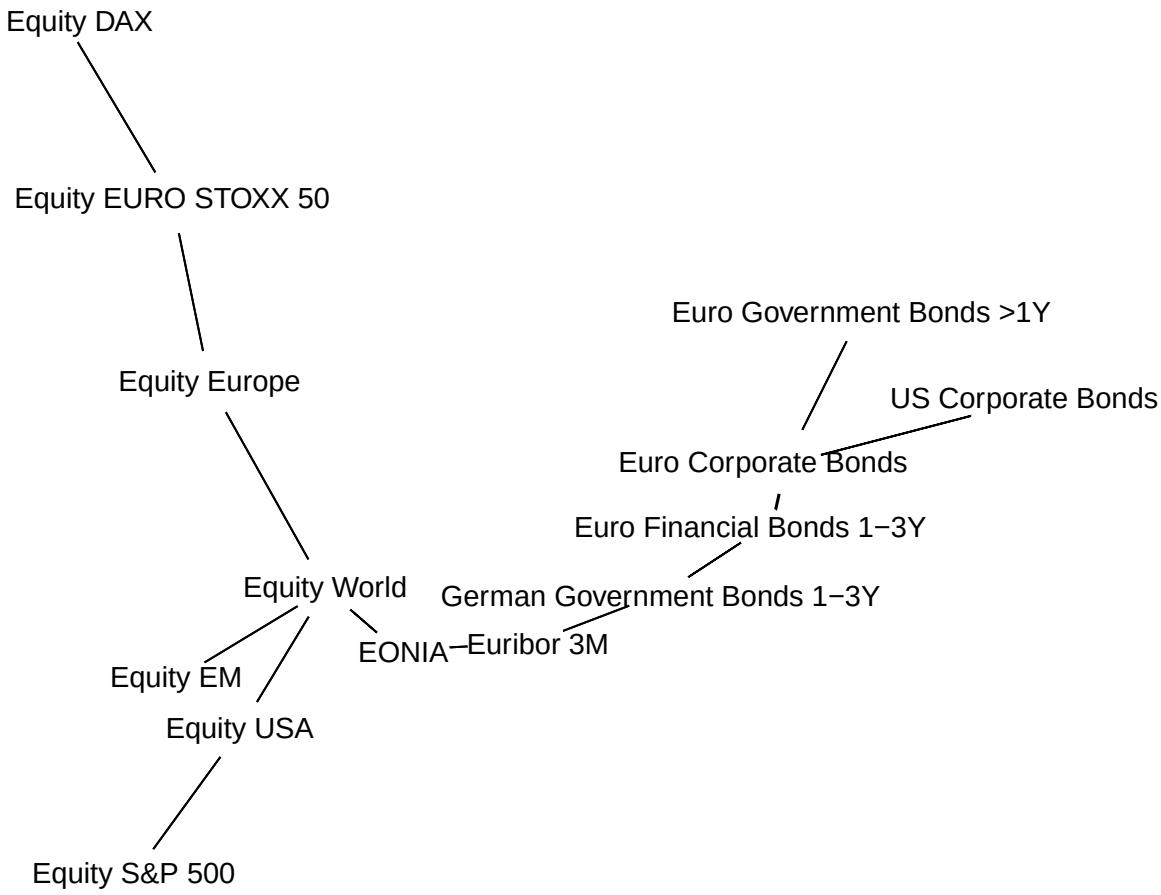
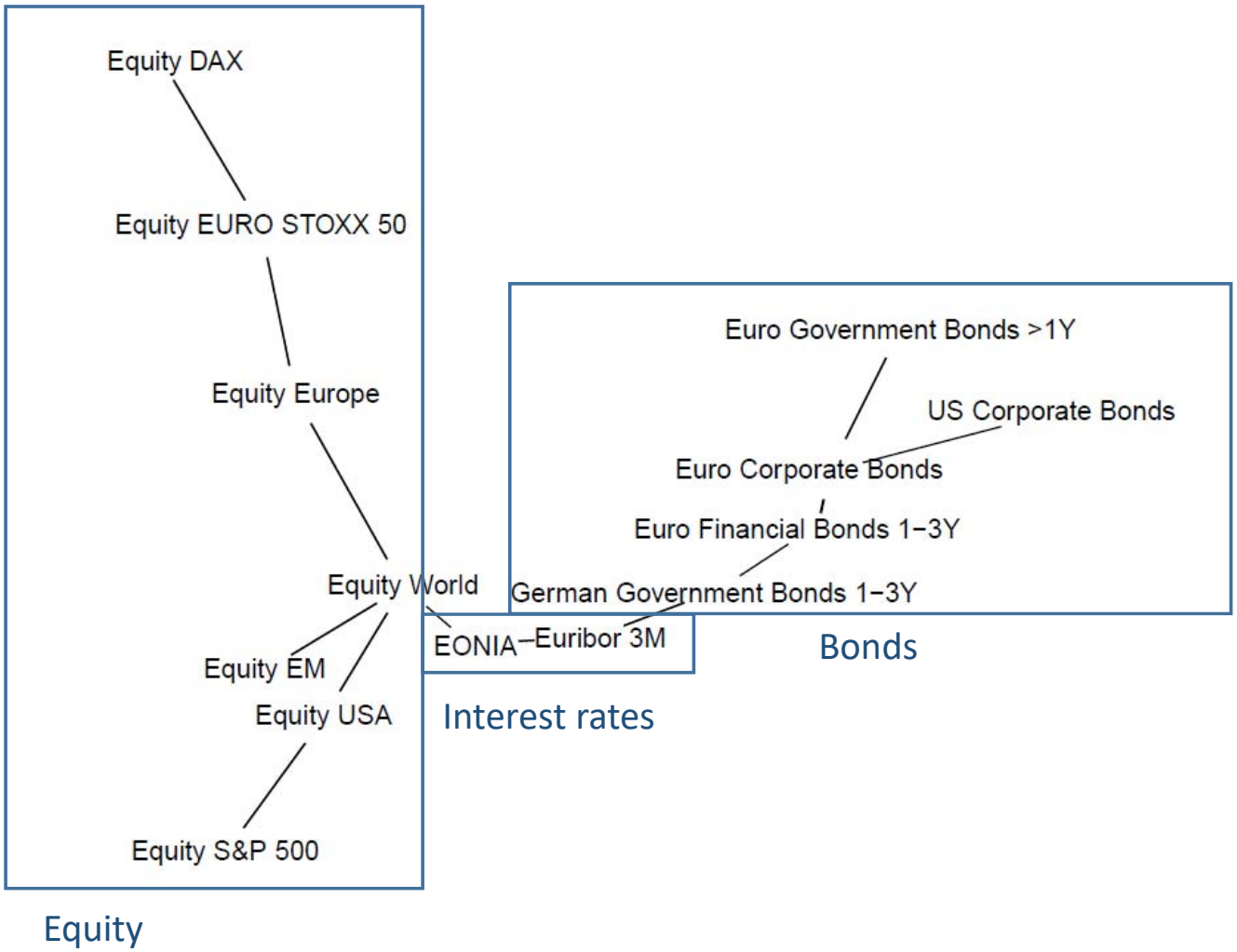
Example of main financial indices on 10 years of financial returns



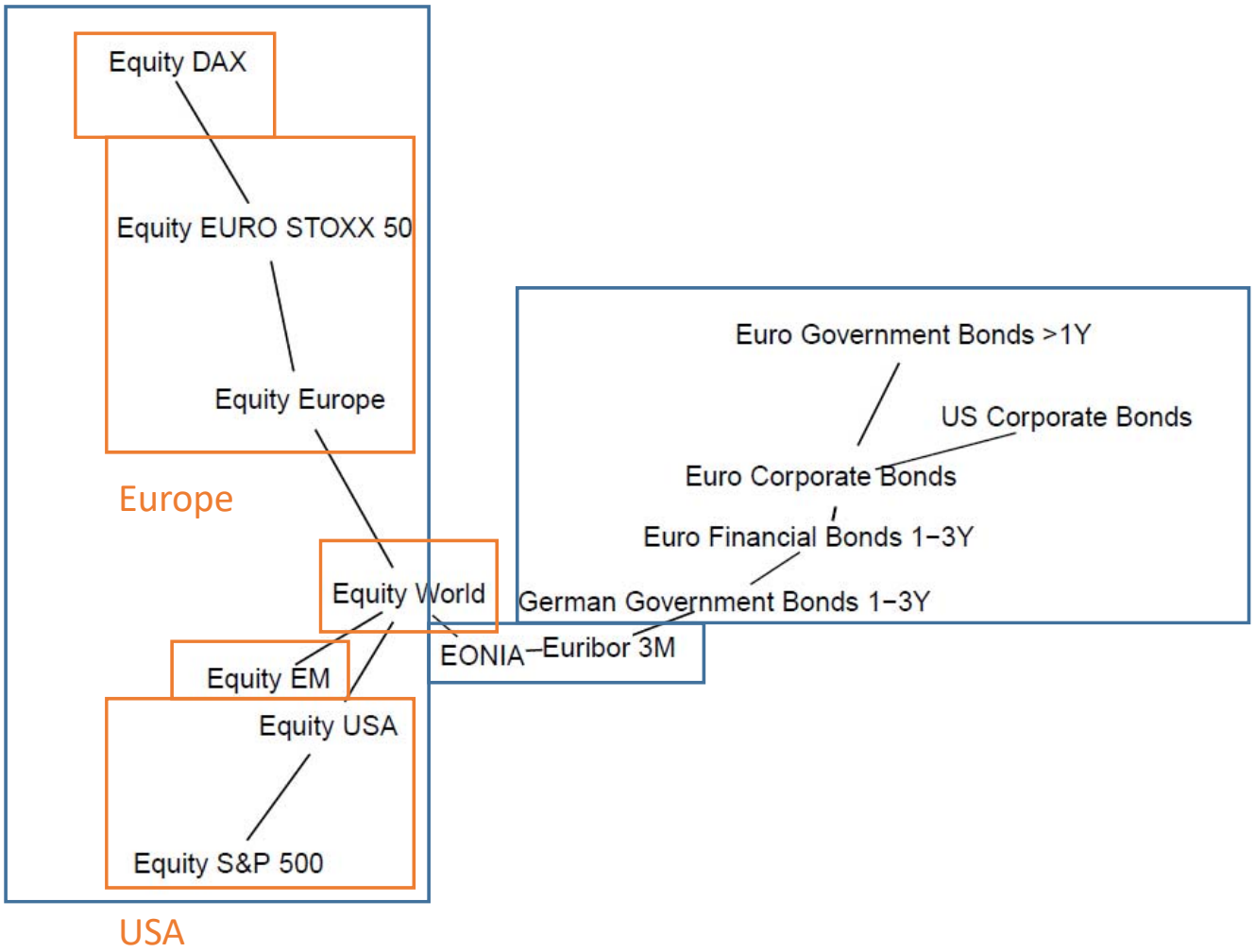
Example of main financial indices on 10 years of financial returns

Asset decomposition



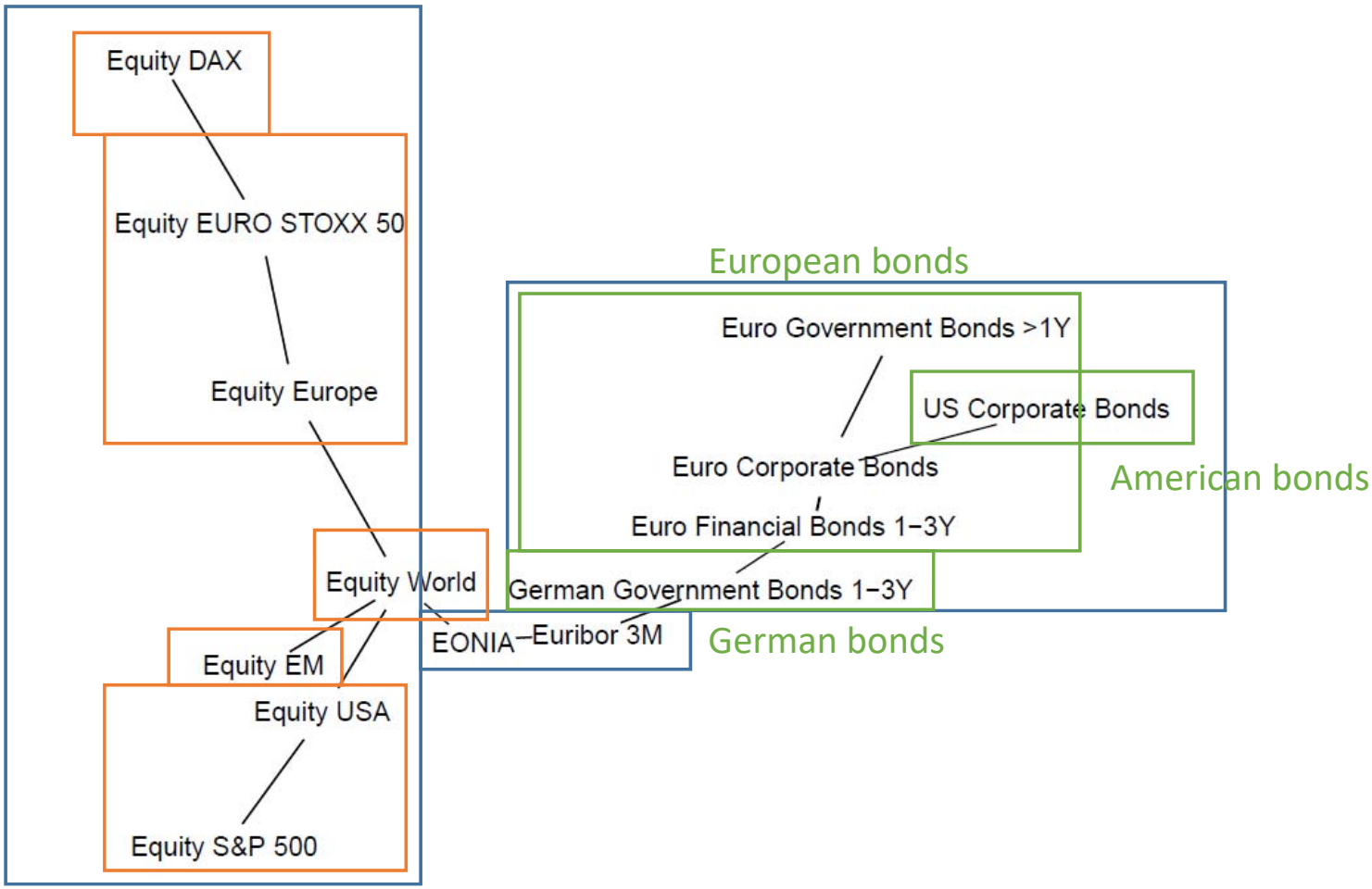
Example of main financial indices on 10 years of financial returns

Asset decomposition
Equity geographic decomposition



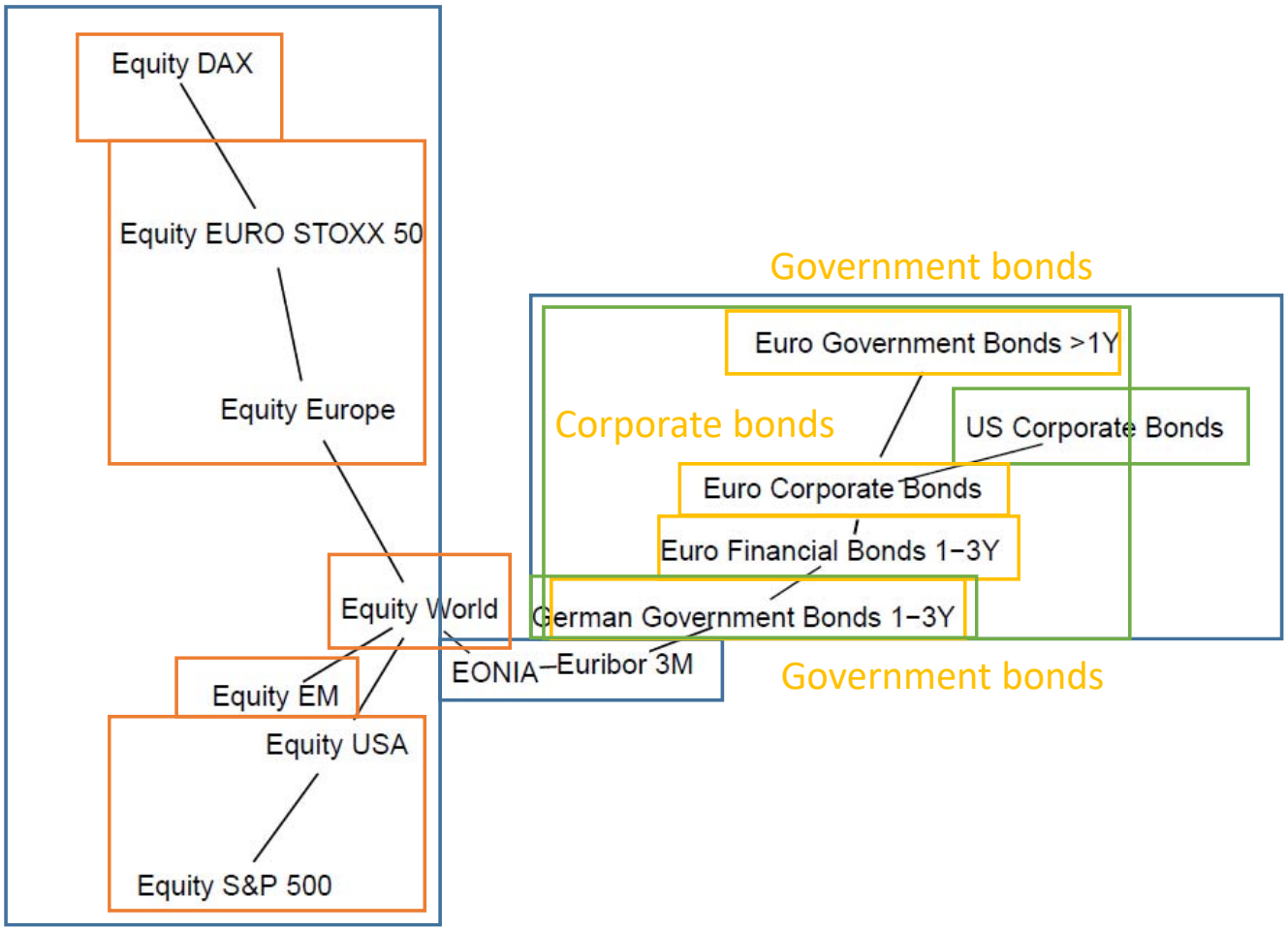
Example of main financial indices on 10 years of financial returns

Asset decomposition
Equity geographic decomposition
Bond market decomposition



Example of main financial indices on 10 years of financial returns

Asset decomposition
Equity geographic decomposition
Bond market decomposition
Bond type decomposition



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Definition & Providers

- A market index is a selection of a pool of assets selected according to some crietria.
- Main indices providers are MSCI, Markit, ICE, HFR, Bloomberg, FTSE, JPM, ...

IHS Markit™

MSCI 

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A need of preliminary work

The target to have a preliminary work to pre-select market indices is designed to select the most relevant market indices for vine copula modeling (and reduce dimensionality)

- The decomposition is a quantitative methodology dependence measures with market indices
- It help to select 10 market indices over 1500+ (quantitative portfolio analysis)
- The target of the methodology is to determine investment fund characteristic
- The methodology should be used to decompose characteristics by characteristic (asset class, sectorial exposure, regional exposure, etc)

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Application data sets

Is the top tail correlated index a good index for asset class determination?

- financial period of 31/12/2017 to 31/12/2018
- daily returns of 755 different fund strategies
- 1067 base of market indices with a target of reduction to 10

	TRUE/FALSE Ratio
Equity	81.17%
Bond & Mixed Strategies	51.97%
Total	61.00%

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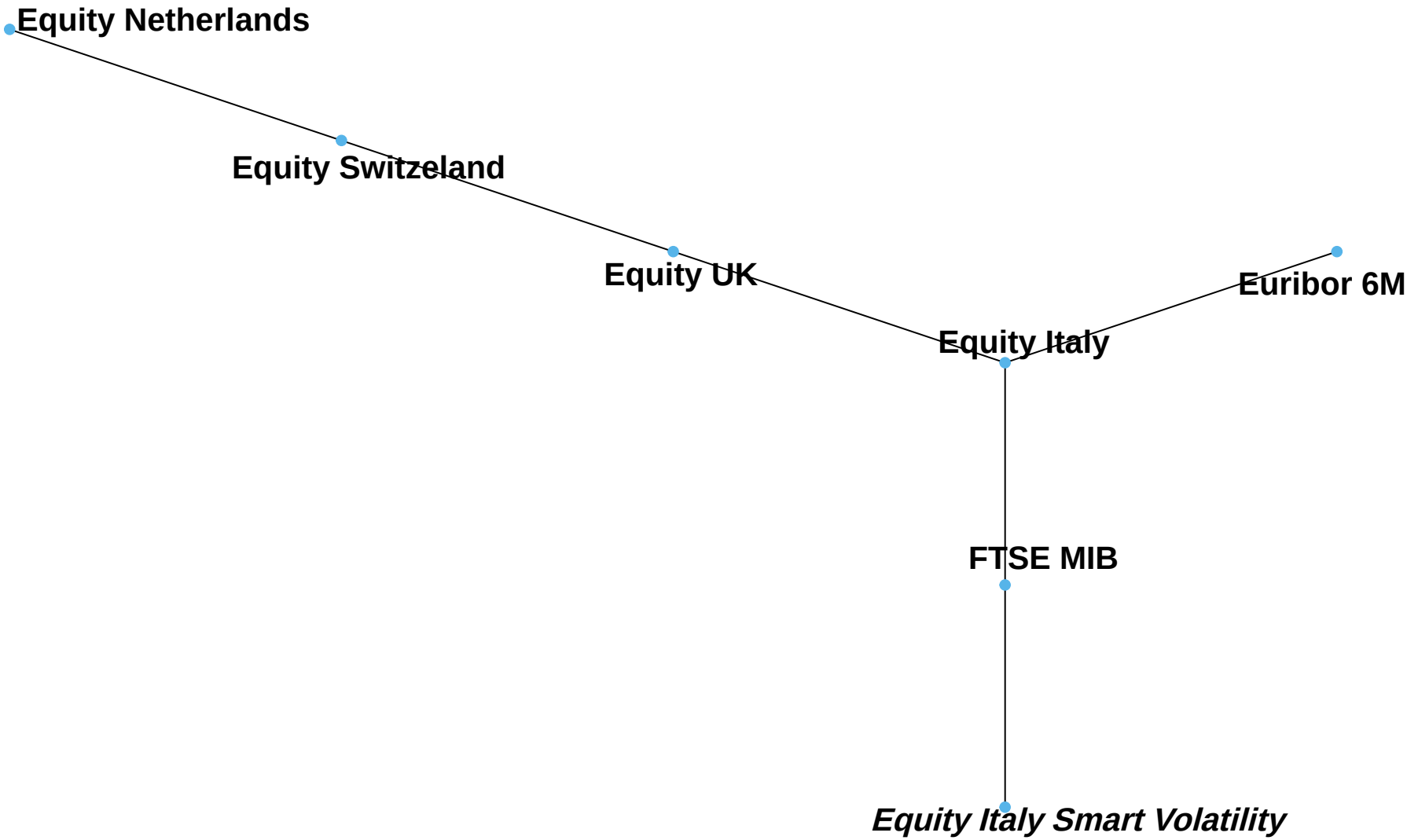
Example of resulting vine copula



Pair densities on tree 1

Euribor 6M, Equity Italy	Equity Italy Smart Volatility, FTSE MIB	FTSE MIB, Equity Italy	Equity Netherlands, Equity Switzeland	Equity Italy, Equity UK	Equity Switzeland, Equity UK