A Traverse from the Micro to the Macro

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Tim Geithner, President of the FRBNY, noted that a common characteristic of financial crises has been:

> "[T]he confluence of a sharp increase in risk perception, and the subsequent actions taken by financial institutions and investors to limit their exposure to future losses. As asset prices declined and volatility increased in response to increased concern about risk, firms moved to call margin, to reduce positions and to hedge against further losses. These individual actions had the aggregate effect of inducing even larger price declines and further heightening perceptions of risk, ultimately propagating and amplifying the effects of the initial shock."

In the rest of this short paper I shall discuss three ways whereby such second, and subsequent, round effects may be assessed, so that the aggregate system's overall final equilibrium may be estimated:-

1. by iteration with individual banks;

2. by estimating the portfolio effect on all banks, taken together, of changes in the marginal conditions of individual banks;

3. by a top-down model that allows us to simulate the effect of shocks on the economic behaviour of the main banks in the system.

Figure 1

1. Extended macro-stresstests:
Three-Stage Model

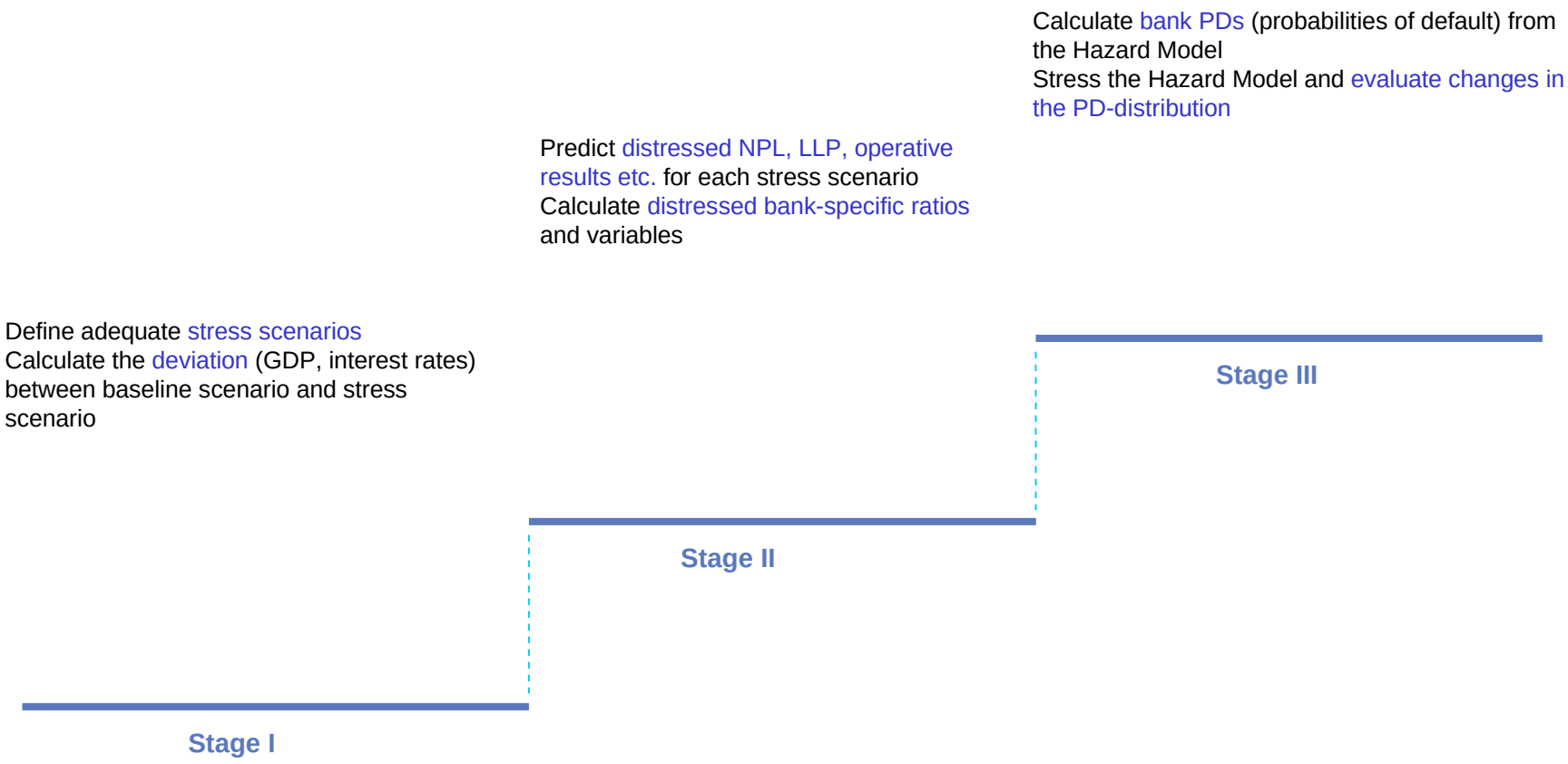


Figure 2

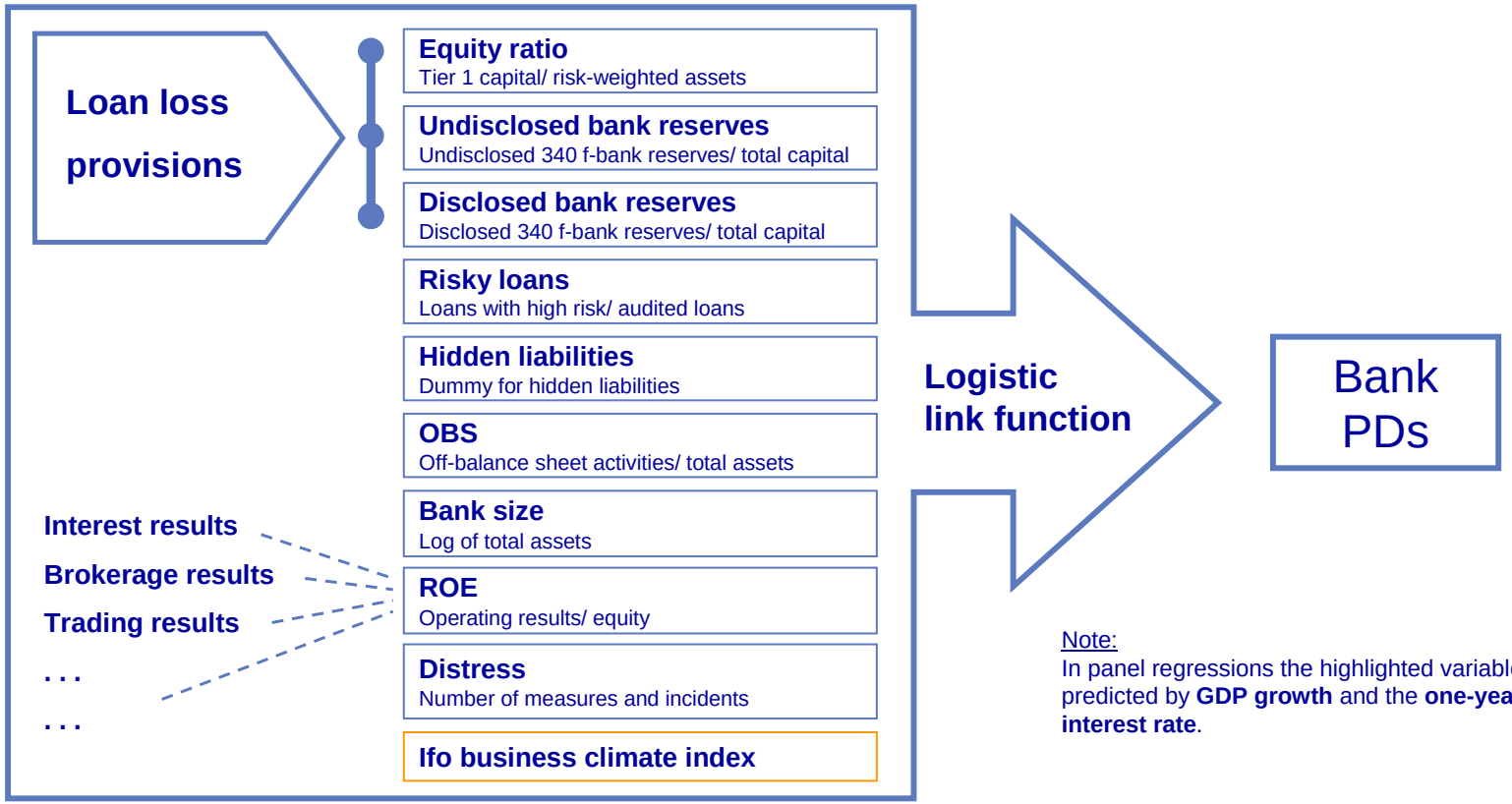
1. Extended macro-stresstests:
Stage II: Forecasting distressed bank balance sheet data

- For each scenario distressed bank balance sheet data is predicted with the micro-econometric bank model of the Bundesbank (BbkMicBM):
  - *Non performing loans*
  - *Loan loss provisions*
  - *Interest results*
  - *Brokerage results*
  - *…*

- This data is used to stress the Bundesbank Hazard Model (BBK HRM)

Figure 3

1. Extended macro-stresstests:
Stage III: Stressing the Bundesbank Hazard Model



Note:
In panel regressions the highlighted variables are predicted by **GDP growth** and the **one-year interest rate**.

Figure 4

International Monetary Fund

Default Dependence

Why not correlation?

Adequate measure of dependence for spherical and elliptical distributions; e.g. multivariate normal distributions

→ **Financial assets not represented by distributions of this class**

→ **Heavy tailed distributions might not even have finite variances**

Data might be highly dependent while correlation is zero

→ **Independence implies zero correlation but not the opposite**

Correlation is not invariant under non-linear transformations

→ $\rho\left(T\left(X\right),T\left(Y\right)\right)\neq\rho\left(X,Y\right)$

Measure of dependence in the center of the distribution. Gives little weight to tail events when evaluated empirically

→

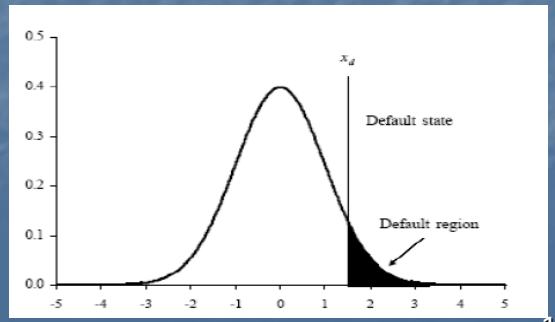


Figure 5

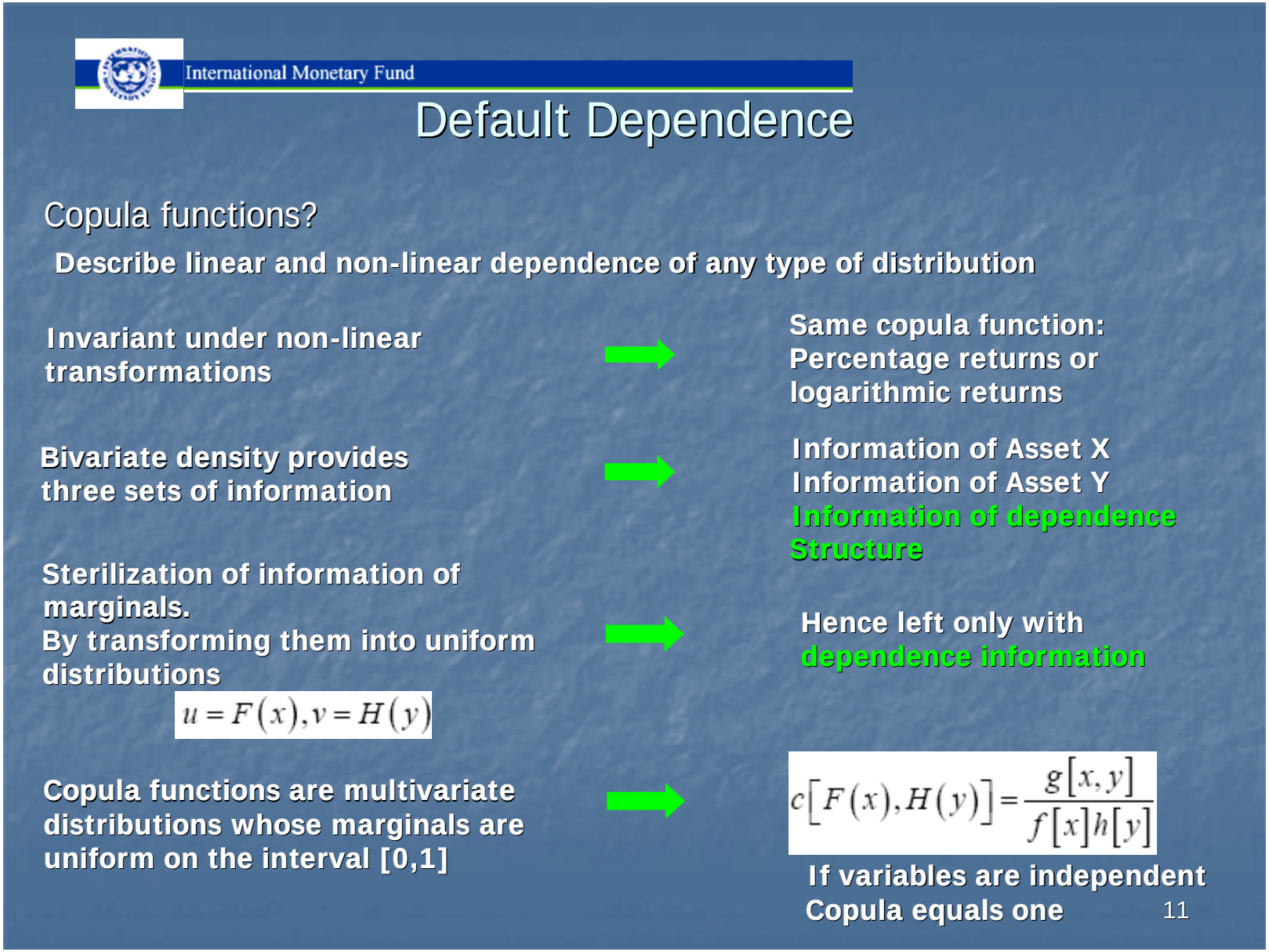

International Monetary Fund
Default Dependence
Copula functions?
Describe linear and non-linear dependence of any type of distribution
Invariant under non-linear transformations
Same copula function: Percentage returns or logarithmic returns
Bivariate density provides three sets of information
Information of Asset X
Information of Asset Y
Information of dependence Structure
Sterilization of information of marginals.
By transforming them into uniform distributions
$u = F(x), v = H(y)$
Hence left only with dependence information
Copula functions are multivariate distributions whose marginals are uniform on the interval [0,1]
$c[F(x), H(y)] = \frac{g[x,y]}{f[x]h[y]}$
If variables are independent Copula equals one
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Figure 6

International Monetary Fund

Default Dependence

In contrast to the “standard” copula approach

1. Using entropy based estimation, we infer the multivariate density of the portfolio (*CIMDO-density*)

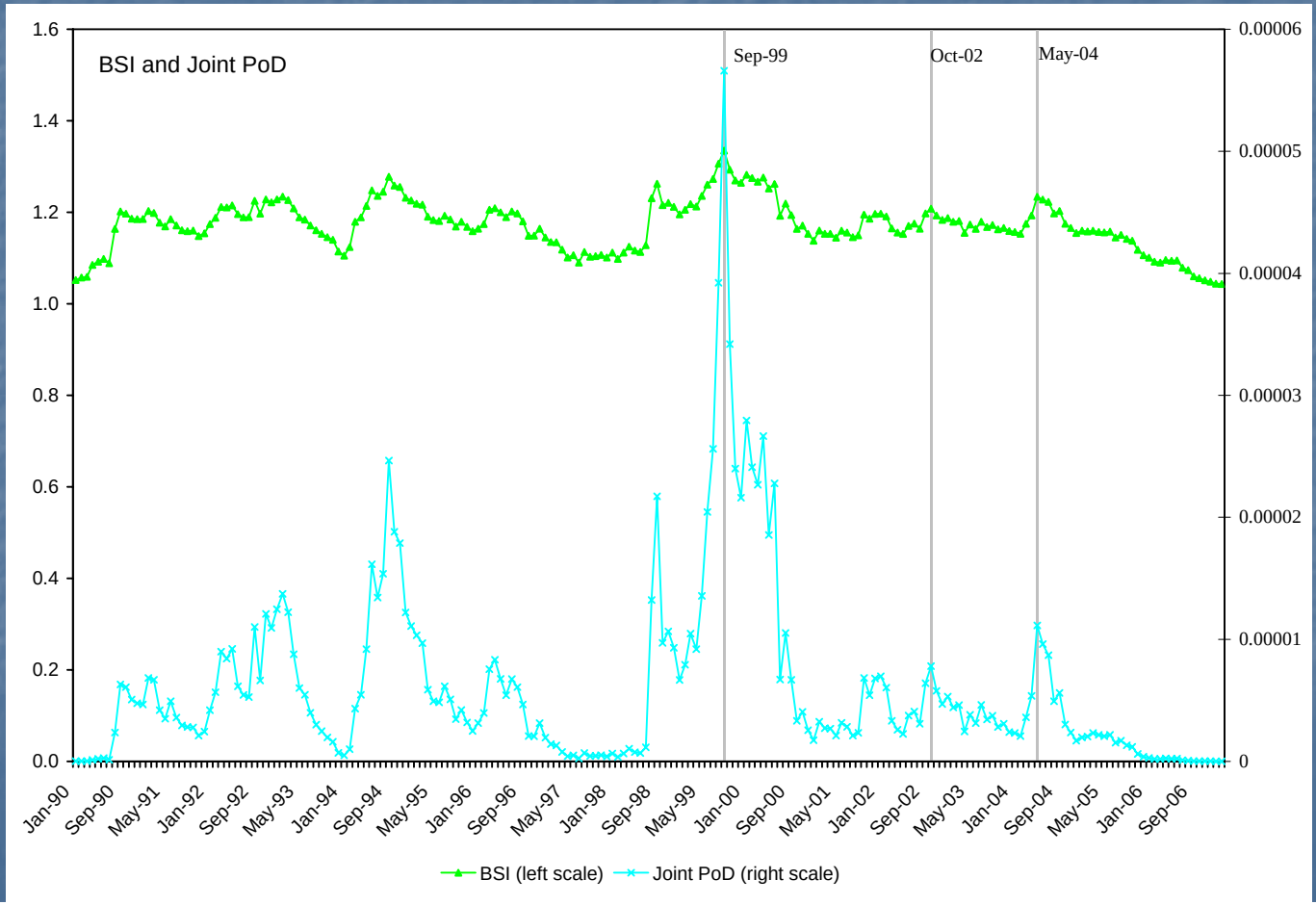
2. This density has the copula embedded within it

3. We “extract” the copula; i.e. the *CIMDO-copula*, via (Sklar’s Theorem)

Figure 7

International Monetary Fund

BSI and Joint PoD



Key features of Model

(1) Heterogeneous investors, banks and bank customers

(2) Incomplete Markets

(3) Default treated continuously

(4) Money and Liquidity